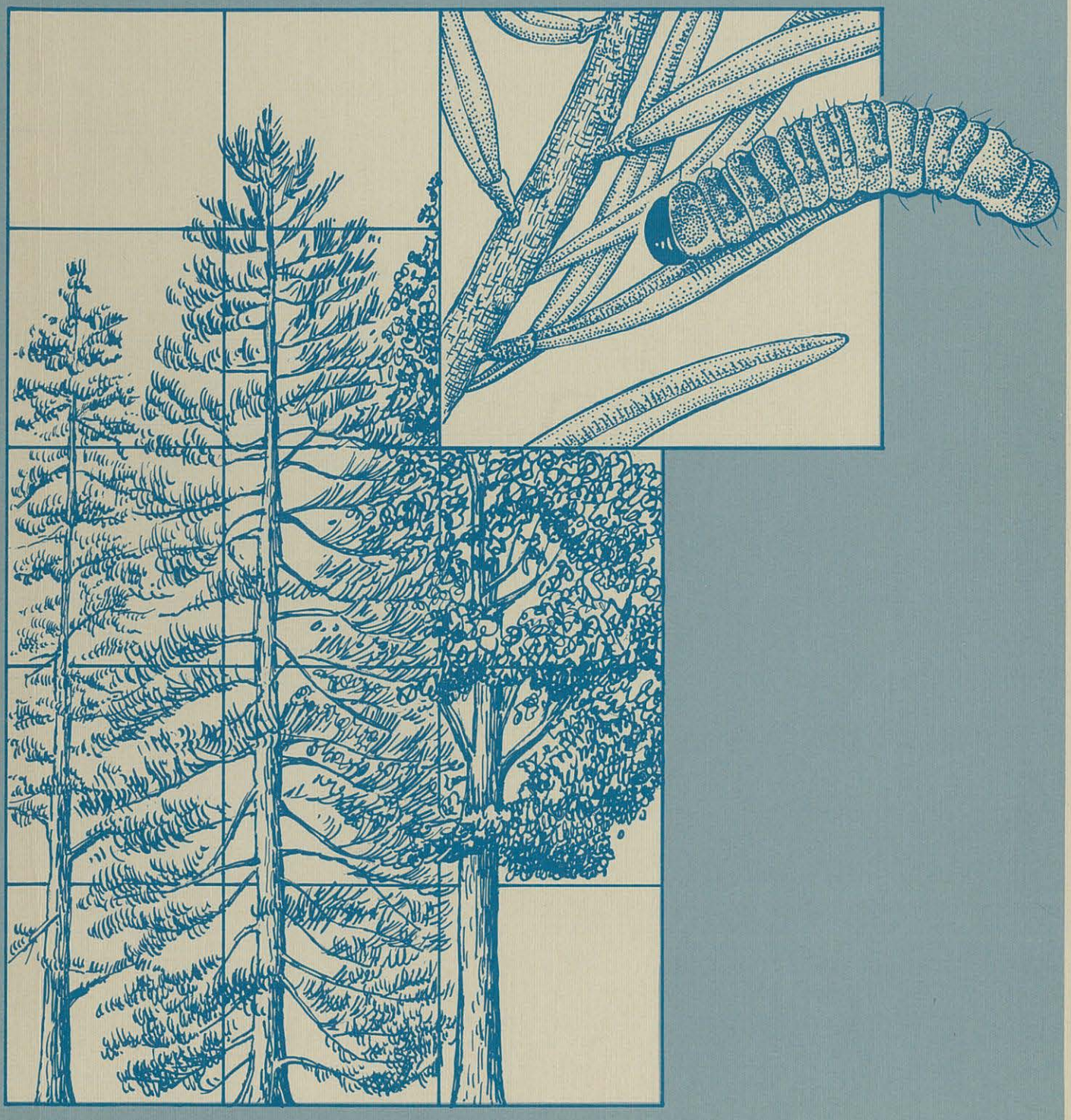
1983

MICHIGAN FOREST PEST REPORT



1983

MICHIGAN FOREST PEST REPORT

Edited by

S. L. Battenfield

Michigan Cooperative Forest Pest Management Program:

D. G. Mosher, Department of Natural Resources, Co-Director Field Applications
G. A. Simmons, Michigan State University, Co-Director Technology Transfer
L. F. Wilson, USDA Forest Service, Co-Director Research and Development

Member Institutions:

Michigan Department of Agriculture, Plant Industry Division
Michigan Department of Natural Resources
Michigan State University
Michigan Technological University
University of Michigan
USDA Forest Service
USDA Animal Plant Health Inspection Service
Michigan Forest Industries

Annual Report 1983

Contributors

(in alphabetical order)

E. Abel, Michigan Department of Agriculture
R. Breyer, Cooperative Extension Service
J. Bruhn, Michigan Technological University
C. Chilcote, Michigan State University
R. Drapek, Michigan State University
J. Dreves, Michigan Department of Agriculture
G. Dunn, Michigan State University
G. Gregory, University of Michigan
J. Hart, Michigan State University
R. Heyd, Michigan Department of Natural Resources
D. Huff, University of Michigan
A. Lynch, University of Michigan
W. Mattson, Michigan State University
L. McKee, Jr., Michigan State University
J. Miller, Michigan State University
B. Montgomery, University of Michigan
L. Moore, United States Department of Agriculture Forest Service
D. Mosher, Michigan Department of Natural Resources
R. Murray, Michigan Department of Natural Resources
S. Perry, Michigan State University
R. Priest, Michigan Department of Agriculture
T. Proffer, Michigan State University
T. Prokrym, Michigan State University
R. Rogan, Michigan State University
H. Russell, Michigan State University
F. Sapio, Michigan State University
G. Simmons, Michigan State University
B. Tabashnik, Michigan State University
L. Wilson, United States Department of Agriculture Forest Service
J. Witter, University of Michigan

Table of Contents

PEST CONDITIONS: UPPER PENINSULA

- Spruce Budworm 1
- Jack Pine Budworm 1
- Gypsy Moth 2
- Orangehumped Mapleworm 2
- Forest Tent Caterpillar 2
- Oak Wilt 2
- Other Pest Problems 3
- Maps 6

PEST CONDITIONS: LOWER PENINSULA

- Jack Pine Budworm 10
- White Pine Weevil 12
- Red Pine Shoot Moth 13
- Saratoga Spittlebug 13
- Cherry Scallop Shell Moth 13
- Oak Skeletonizer 13
- Pine Spittlebug 13
- Redheaded Pine Sawfly 14
- Redhumped Oakworm 14
- Oak Webworm 14
- Oak Wilt 14
- Maple Decline/Water Stress 14
- Scleroderris 14
- Other Pest Problems 16
- Maps 18

SPECIAL REPORTS

- Disease Problems: Lower Peninsula 33
- Ornamental Tree Pests 33
- Gypsy Moth Parasite Work 33
- CCMS: Gypsy Moth Trapping 33
- Gypsy Moth Management Program 34
- Conophthorus Cone Beetle Study 34
- Balsam Fir and White Spruce Resistance to Spruce Budworm 35
- Tarnished Plant Bug on Poplar 35
- Research at the Forest Entomology Lab at Michigan State University 35
- Research at the University of Michigan 36
- Projects of the Michigan Department of Natural Resources in the Upper Peninsula 38
- Vegetative Compatibility Groups, Water Potential, and *Cytospora kunzei* 40
- Bigtooth Aspen and Sewage Sludge 40
- Research and Programs at the Michigan Technological University 40

PUBLICATIONS OF THE MICHIGAN COOPERATIVE FOREST PEST MANAGEMENT PROGRAM IN 1983 43

Pest Conditions: Upper Peninsula

Robert Heyd

SPRUCE BUDWORM
(Choristoneura fumiferana)

Aerial surveys of spruce-fir defoliation, conducted over 5.6 million acres of state and private forest land, showed that spruce budworm damage was more severe this year than in the past two years. Of the 145,952 acres defoliated, 40,960 acres were heavily defoliated, 50,400 acres were moderately defoliated, and 54,592 acres were lightly defoliated (Table 1; map pg. 6). Ninety percent of the observed heavy defoliation was in three counties (Delta, Dickinson, and Marquette) where expanses of mature balsam fir still exist. Spruce plantations in Schoolcraft County, untouched by previous outbreaks, were moderately defoliated.

An aerial survey of the Hiawatha National forest conducted by the USDA Forest Service in late July/early August, showed defoliation on 24,857 acres: 18,176 acres of light defoliation, 6,579 acres of moderate defoliation, and 102 acres of heavy defoliation (Table 2). This was an increase in light defoliation levels, but a decrease in heavy defoliation.

Table 1. Acres of spruce-fir defoliated by the spruce budworm.

	Acres Defoliated*		
Counties	Light	Moderate	Heavy
Alger	2,880	-	1,280
Baraga	640	3,200	320
Chippewa	14,080	928	960
Delta	1,920	16,960	14,080
Dickinson	5,120	7,680	12,800
Houghton	1,920	640	-
Iron	-	2,880	-
Keweenaw	-	2,560	-
Luce	17,152	5,120	-
Mackinac	1,920	-	-
Marquette	4,480	5,760	10,240
Menominee	1,920	-	-
Schoolcraft	2,560	4,672	1,280
Totals	54,592	50,400	40,906

Total Acres Defoliated = 145,952

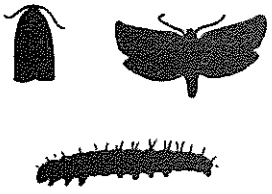
*Light defoliation: light brown cast to trees; less than 50% loss of current needles.
Moderate defoliation: Tree tops with darker brown cast than lower canopy; more than 50% loss of current year's needles.
Heavy defoliation: deep brown cast over entire tree; 100% loss of current year's needles with some back-feeding.

Table 2. Spruce budworm damage in the Hiawatha National Forest.

	Acres	
Defoliation	Federal	Private
light	12,340	5,836
moderate	4,710	1,869
heavy	51	51
Totals	17,101	7,756

Total Acres Defoliated = 24,857

JACK PINE BUDWORM
(Choristoneura pinus)

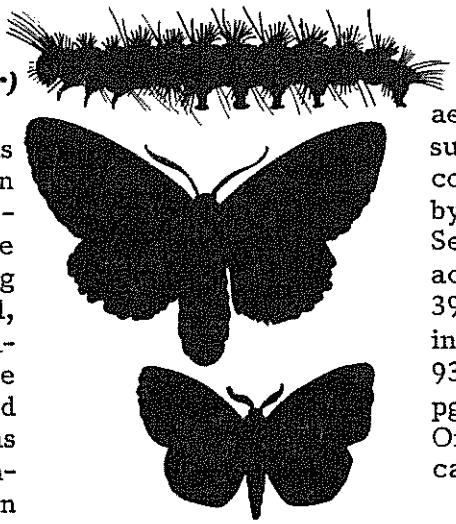


Jack pine budworm damage increased from 1982 (the first year of significant defoliation in 10 to 12 years). This year ground surveys detected 30 to 50 acres of heavy defoliation, 100 to 120 acres of moderate defoliation, and 200 to 300 acres of light defoliation in Schoolcraft County (map pg.7). These areas are not completely jack pine trees.

Aerial surveys conducted by the USDA Forest Service showed the increase in defoliation was limited to two areas: the

Manistique Ranger District southeast of East Lake and the Sault Ste. Marie Ranger District north of Raco airfield. Total acreage defoliated was 1,535, with 435 acres of light defoliation, and 1,100 acres of moderate defoliation.

GYPSY MOTH
(Lymantria dispar)

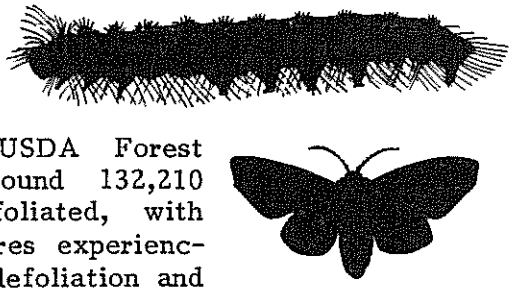


Nineteen moths (18 more than in 1982) were collected in five separate counties. No egg masses were found, indicating populations may not have become established yet. However, as gypsy moth-infested areas in Lower Michigan spread, the chances for moths, pupae, and egg masses to enter the U.P. will increase.

ORANGEHUMPED MAPLEWORM
(Symmerista leucitys)

The orange-humped mapleworm defoliated sugar maple in extensive areas of northern Chippewa County north of Strongs (map pg. 7). A 1,500-acre block of hardwood forest type was completely defoliated, with scattered small pockets of defoliation in the surrounding area. Much public concern was voiced. The people in the area understand that this late season defoliation is not a serious tree stressor. Thus, a decision to spray next year will be based on aesthetic criteria and nuisance values associated with the extreme abundance of the larvae in late summer. Defoliation was first noticed in 1982 and probably will be heavy for the next two years.

FOREST TENT CATERPILLAR
(Malacosoma disstria)



An aerial survey conducted by the USDA Forest Service found 132,210 acres defoliated, with 39,731 acres experiencing light defoliation and 93,389 acres being heavily defoliated (map pg. 8). The infestation increased in Ontonagon County, but decreased significantly in Gogebic County.

OAK WILT
(Ceratocystis fagacearum)

In the Shakey Lake area, 26 epicenters of very susceptible red oak (over a 10,600-acre area) are threatened by oak wilt. To date, over 3,000 trees have been lost (map pg. 9). In 1982, Vapam was used to create root graft barriers to stop the underground spread of the disease where it was near a residence. The barriers were effective; however, in 1983, a few trees outside the barriers had oak wilt. To prevent further spread, herbicides (Tordon and Velpar) were used to kill infected trees and their root systems and adjacent, potentially infected trees.

A full-scale control program will be mounted in 1984 by the DNR, MTU, MDA, and the Cooperative Extension Service.

OTHER PEST PROBLEMS: 1983
Upper Peninsula

Pest	Host	Counties	Remarks
Insects			
Aspen Blotch Miner *(Lithocolletis tremuloidiella)*	Aspen *(Populus sp.)*	Throughout	Damage noticeable, but much reduced from last year.
Balsam Fir Sawfly *(Neodiprion abietis*	Balsam Fir *(Abies balsamea)*	Delta	Affected areas near Lake Michigan shoreline.
Birch Leafminer *(Fenusa pusilla)*	White or Paper Birch *(Betula papyrifera)*	Throughout	Populations seemed to be low in most areas for the third year.
Birch Skeletonizer *(Bucculatrix canadensisella)*	White or Paper Birch	Throughout	Damage levels down significantly from last 2 years. Localized areas of light to moderate damage only.
Bladder Gall Mites (Eriophyid mites - probably *Vasates quadripedes)*	Silver and Red Maple *(Acer saccharinum* and *A. rubrum)*	Throughout	Several inquiries handled, but down considerably from previous year.
Bronze Birch Borer *(Agrilux anxius)*	White or Paper Birch	Throughout	
Eastern Pine Shoot *(Eucosma gloriola)*	Jack Pine *(Pinus banksiana)*	Luce, Baraga	Loss of 40-80% of the terminal shoots in localized areas in two plantations.
Fall Cankerworm *(Alsophila pometaria)*	Hardwoods	Throughout	Little reported defoliation. Adults numerous with many inquiries, such as, "What is this small whitish moth in hardwoods (maybe stands) that flies around even when it's snowing?"
Larch Sawfly *(Pristiphora erichsonii)*	European Larch *(Larix decidua)*	Baraga	5-year-old planting with light infestation.
Maple Trumpet Skeletonizer *(Epinotia aceriella)*	Sugar Maple	Throughout	Third year in a row with localized areas where most leaves on a tree were injured. Many calls from concerned people.

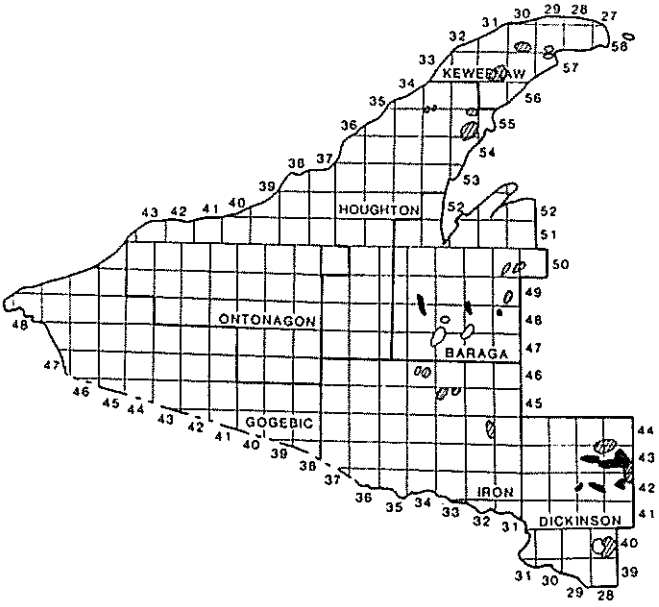
Other Pest Problems: 1983 (continued)

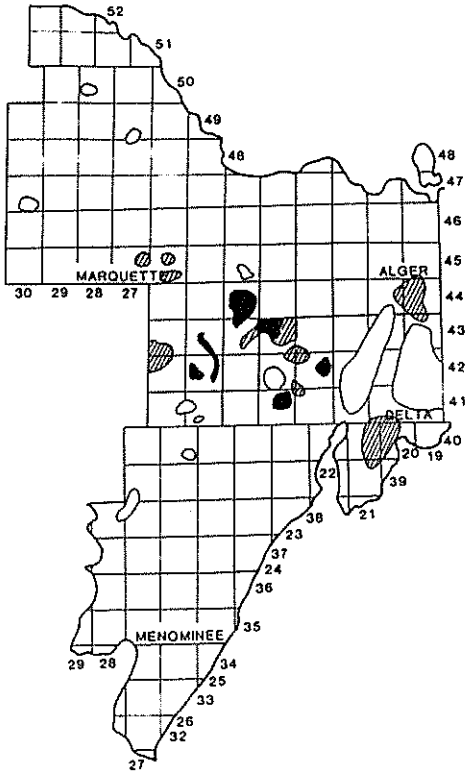
Pest	Host	Counties	Remarks
Pine Root Collar Weevil *(Hylobius radicus)*	Scots Pine *(Pinus silvestris)*	Throughout	May be a limiting factor to Scots pine plantation efforts in the U.P.
Pine Spittlebug *(Aphrophora paralella)*	Scots Pine White Pine		Populations down from last few years.
Red Pine Needle Midge *(Contarinia sp.)*	Red Pine *(Pinus resinosa)* Scots Pine	Delta, Dickinson, East Iron, Marquette	Additional areas detected this year. Found on Scots pine in 1983. Symptoms on Scots pine resemble scleroderris but without stem canker. No needle droop on Scots pine and needles persist into fall.
Red-Headed Jack Pine Sawfly *(Neodiprion virginianus)*	Jack Pine	North Schoolcraft	An isolated pocket of light defoliation.
Red-Headed Pine Sawfly *(Neodiprion lecontei)*	Red Pine	Luce, Mackinac	Five plantations with small pockets of heavy defoliation. This may represent a building population in this area and will be watched closely in 1984.
Variable Oak Leaf Caterpillar *(Heterocampa manteo)*	Beech *(Fagus grandifolia)*	Alger, Delta	Localized areas of heavy defoliation around lakes on Alger-Delta County line. (map pg. 9)
White Grubs *(Phyllophaga sp.)*	Red Pine	Alger, Marquette, Menominee, Schoolcraft, Luce	Populations down this year.
White Pine Weevil *(Pissodes strobi)*	Jack Pine	Marquette	Jack pine is weevilled throughout U.P.; however, unusually heavy weevilling was detected in 5-10-year-old jack pine south of Ishpeming.
Yellow-Headed Spruce Sawfly *(Pikonema alaskensis)*	White Spruce *(Picea glauca)*	Marquette	A few isolated trees only.

Other Pest Problems: 1983 (continued)

Pest	Host	Counties	Remarks
Diseases			
Gall Rusts *(Cronartium quercuum)* *(Endocronartium harknessii)*	Jack Pine Scots Pine	Throughout	Prohibits jack pine and Scots pine production in some areas.
Hypoxylon Canker *(Hypoxylon mammatum*	Quaking Aspen *(Populus tremuloides)*	Throughout	
Needlecast or Tar Spot *(Hypodermella ampla)*	Jack Pine	Marquette	Small pockets in 10-year-old jack pine where current year's growth affected.
Rhizophaera Needlecast *(Rhizosphaera kalkhoffi)*	Spruce *(Picea sp.)*	Delta, Menominee	Christmas tree plantations.
Scleroderris Canker *(Gremmeniella abietina)*	Red and Jack Pine	Alger, Luce, Marquette, Schoolcraft	Light flagging in lower whorls in some areas.
Swiss Needlecast *(Phaeocryptobus gaumamnae)*	Douglas-Fir *(Pseudotsuga menziesii)*	Delta, Menominee	Christmas tree plantations.
Verticillium Wilt *(Verticillium albo-atrum)*	Sugar Maple	Chippewa	Severe drought plus poor planting practices predisposed 40 B&B sugar maple saplings. Some of these displayed signs and symptoms of verticillium wilt.
White Trunk Rot of Aspen *(Phellinus tremulae)*	Aspen	Throughout	A large portion of our aspen resource is mature or overmature and in need of harvesting.
Other			
Maple Decline	Sugar Maple	Marquette, Menominee	Continuing problem in urban areas.

SPRUCE BUDWORM

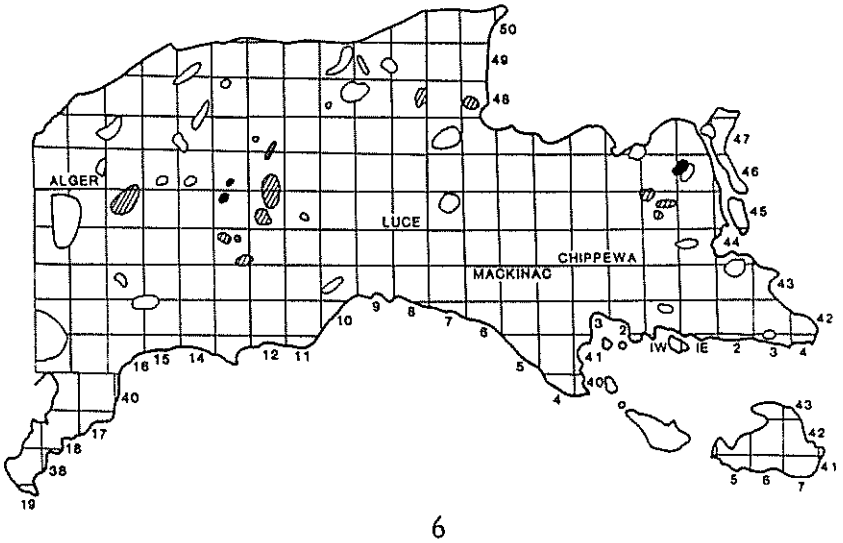


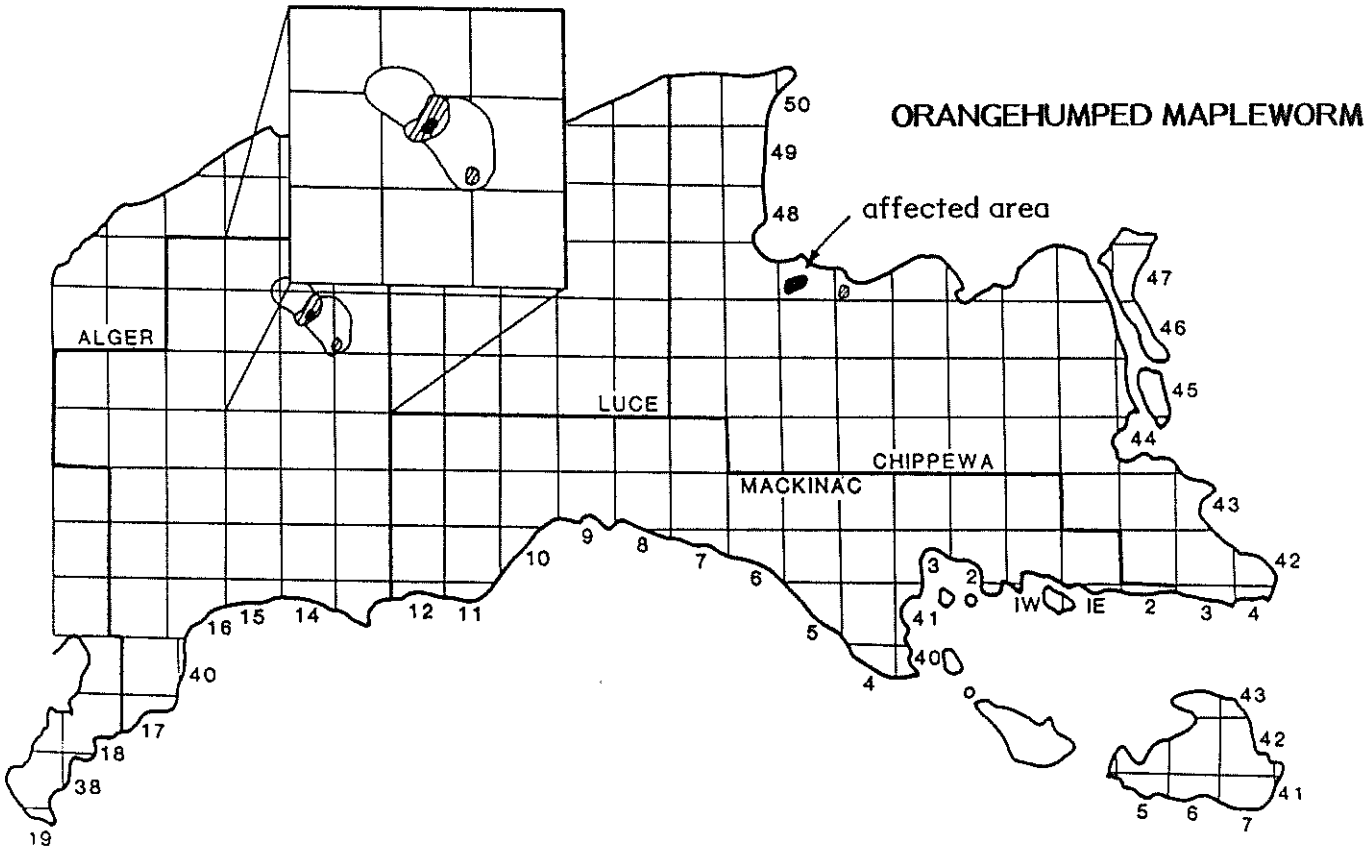


○ light defoliation

▨ moderate defoliation

● heavy defoliation





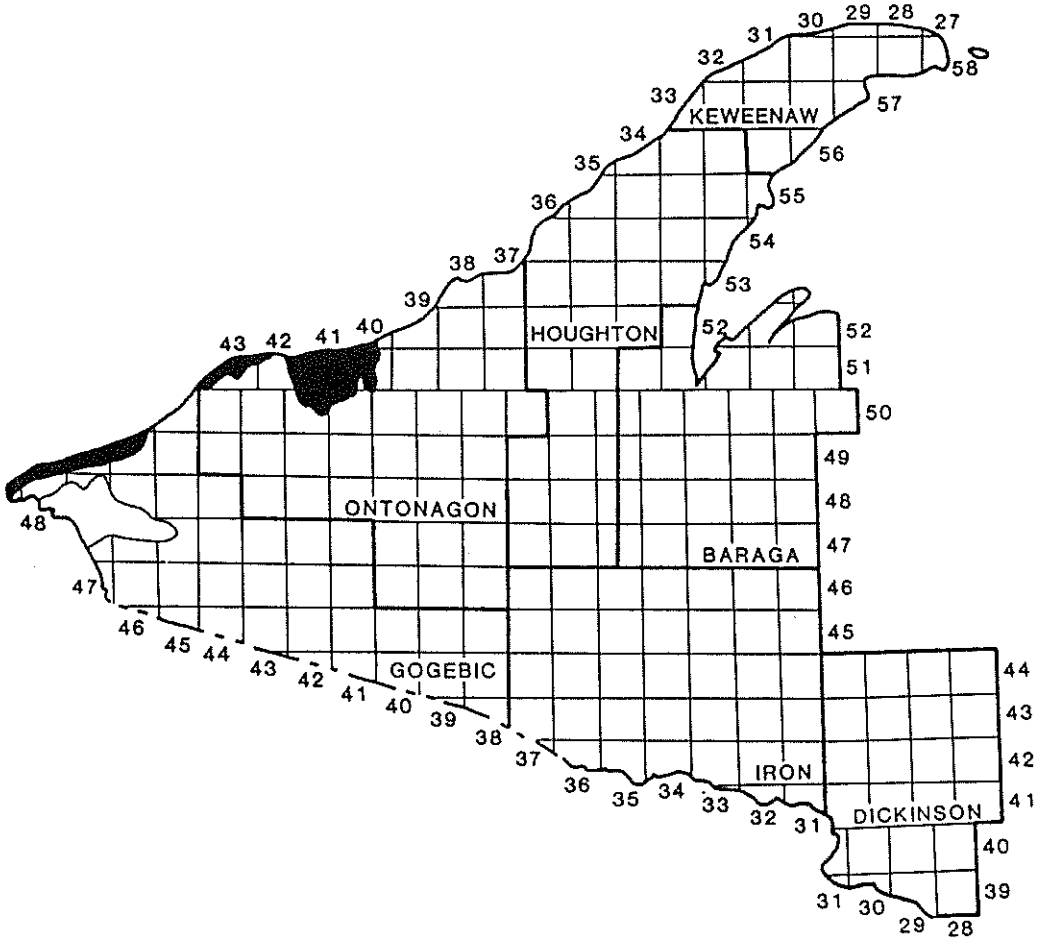
JACK PINE BUDWORM

○ light defoliation

▨ moderate defoliation

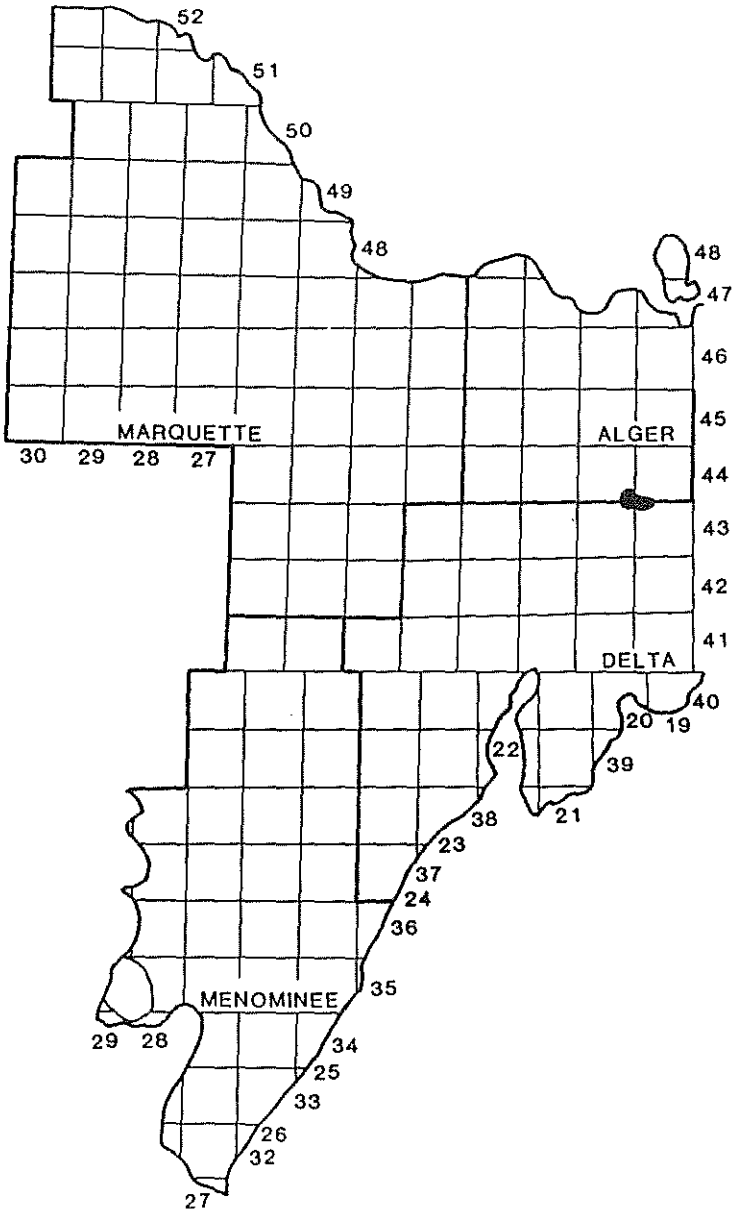
● heavy defoliation

FOREST TENT CATERPILLAR



○ light defoliation

● moderate - heavy defoliation



VARIABLE OAK LEAF CATERPILLAR

● Affected area

OAK WILT

○ Affected area

Pest Conditions: Lower Peninsula

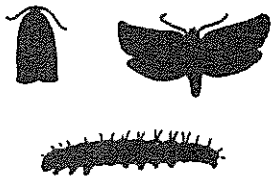
Ron Murray

A major advance in the forest pest management program in 1983 was the addition of three plantation monitors to the summer staff in Region II.

Stationed at Gaylord, Traverse City, and Roscommon, they monitored the plantations (and a few, high-quality, natural stands) 10 years old and less. In all, 10,294 acres in 181 stands were monitored for pest problems (map pg. 18), checked for survival, and risk-rated for various potential pest problems.

A permanent record of the stands and their condition was prepared for entry into the Forest Pest Management Data Base Management System at MSU.

JACK PINE BUDWORM
(Choristoneura pinus)



Defoliation by the jack pine budworm was not as severe in 1983 as it had been in 1982. Stand conditions, however, continued to deteriorate from 1982 levels (Table 3, map pg. 19). An additional 29,000 acres were classed as stand condition level II (less than 10% mortality, 55% growth loss in current year). Of the 599,000 acres defoliated, 289,000 acres were state-owned, 179,000 were privately owned, and 122,000 were federally owned. Populations of early larvae caused top kill and tree mortality on trees less than 8 feet tall in 850 acres of jack pine plantations and well-stocked natural stands. Counties most heavily defoliated were Otsego, Montmorency, Presque Isle, and Cheboygan. (Table 4 shows areas of defoliation.)

A survey of early larval populations in jack pine plantations ten years old and younger showed areas of potential problems (map pg. 20). These areas were surveyed again in a pre-spray, or late larval, survey to see if problems had surfaced (map pg. 20) and would require control. High population areas were designated for treatment, but not all could be sprayed due to location of the plantations (map pg. 21). Areas that were treated were sprayed aerially on July 1 with Sevin-4-oil. A subsequent damage survey showed that the untreated areas sustained some of the heaviest damage (map pg. 21).

Table 3. Stand condition levels for jack pine budworm (in acres).

County	Level I			Level II			Grand Total
	State	Private	Federal	State	Private	Federal	
Alcona	18,510	4,440	-	2,600	8,190	29,820	63,560
Arenac	-	-	-	-	300	-	300
Antrim	-	-	-	10,880	360	-	11,240
Cheboygan	-	-	-	1,920	5,120	-	7,040
Clare	-	-	-	1,780	2,500	-	7,280
Crawford	79,764	64,042	-	12,416	8,789	-	165,011
Gladwin	-	-	-	800	560	-	1,360
Grand Traverse	18,901	4,779	-	6,272	2,261	-	32,213
Iosco	280	4,760	8,640	9,140	3,260	2,540	28,620
Kalkaska	26,312	5,080	-	12,000	1,600	-	44,992
Lake	-	-	-	80	-	-	80
Missaukee	-	-	-	1,920	1,450	-	2,470
Montmorency	7,040	12,000	-	8,080	16,785	-	43,905
Ogemaw	28,820	10,240	-	7,280	5,760	-	52,100
Oscoda	10,590	21,600	5,440	600	31,000	43,520	112,750
Otsego	4,320	1,760	-	9,440	2,720	-	18,240
Presque Isle	-	-	-	13,380	200	-	13,580
Roscommon	4,040	600	-	6,960	22,720	-	34,320
Wexford	-	-	-	4,104	680	-	4,784
TOTAL:	198,577	129,301	14,080	111,752	114,255	75,880	643,845*

*Gross acres (includes other types within boundary)

Level I: average 35% mortality during the rest of the infestation; top kill and deformity; 90% growth loss in current year.

Level II: less than 10% mortality during the rest of the year; top kill and deformity; 55% growth loss in current year.

Permanent plots also were surveyed (maps pgs. 22 and 23). Generally, these plots are natural jack pine stands with the trees 30 to 50 years old. The two types of surveys (young plantations and permanent plots) are conducted to compare the type and severity of budworm damage. Generally, there are fewer budworm populations in the older stands than in the young plantations.

The larval survey (map pg. 22) indicated potential problem areas, which were subsequently surveyed (map pg. 22). The second survey showed that budworm populations decreased substantially, partly due to mortality from parasites. A study conducted by Norman Elliott (Department of Entomology, MSU) in Wexford and Grand Traverse counties showed high parasitism rates on small larvae (40.2 and 54.7%, respectively) and on large larvae (53.9 and 57.1%, respectively).

A subsequent damage survey showed areas of greatest damage (map pg. 23).

Populations of pupae surveyed by the Cooperative Crop Monitoring System in the fall showed which counties had budworm populations that might cause problems in 1984 (map pg. 23). Counties with potential problems were Otsego, Cheboygan, Montmorency, Oscoda, and Crawford.

Aerial surveys of the Huron-Manistee National Forest showed tree mortality to be down from 1982, partly from a change in category parameters. Most defoliation occurred on the Mio and Tawas Ranger Districts. No defoliation by the jack pine budworm was seen in the Manistee National Forest. The Huron National Forest, however, had defoliation over 40,602 acres, with tree mortality on almost 34,000 acres (Table 5).

Table 5. Damage by jack pine budworm in Huron National Forest.

Damage Type	Acres	
	Federal	Private
Defoliation		
light	14,592	2,381
moderate	17,280	3,123
heavy	3,149	77
TOTALS	35,021	5,581
Tree Mortality		
few (10-20%)	2,586	2,893
moderate (20-50%)	9,574	1,997
severe (50+ %)	13,235	3,661
TOTALS	25,395	8,551

Table 4. Areas of current jack pine budworm defoliation (acres).

	Light			Moderate			Heavy			Severe			
County	Private	State	Federal	Private	State	Federal	Private	State	Federal	Private	State	Federal	TOTAL
Alcona	1,080		5,720	1,200		2,560							10,560
Antrim				360	10,880								11,240
Arenac	260	1,760		300									2,320
Cheboygan													0
Clare	11,450	13,420											24,870
Crawford	300	1,280		45,280	86,370	42,240	2,580		800		20		178,870
Gladwin	800	560											1,360
Iosco	640	1,920		3,850	7,200	32,250							45,860
Kalkaska	4,700	17,980											22,680
Lake								40			40		80
Missaukee	600	600		850	420								2,470
Montmorency				11,271	2,360		11,470	2,760		14,631	5,760		48,252
Ogemaw	10,300	16,520		4,020	18,600								49,440
Oscoda	9,710	13,230					11,200	4,000	38,080				76,220
Otsego							6,742	10,830		1,740	7,680		26,992
Presque Isle				200	580			12,800					13,580
Roscommon				21,880	55,040								76,920
TOTAL	39,840	67,270	5,720	89,211	181,450	77,050	31,992	30,430	38,880	16,371	13,500	0	591,714

light: 1-49% of new growth
moderate: 50-75% of new growth
heavy: 75-100% of new growth; 0-25% of old growth
severe: 100% of new growth; 50-75% of old growth

WHITE PINE WEEVIL
(Pissodes strobi)

White pine weevil damage increased in the past year. Most of the counties north of Clare County experienced extreme damage on jack, white, and red pine plantations less than 10 years old (map pg. 24, Table 6a and b). Populations continued to build from 1982 levels. The Pere Marquette State Forest generally had higher levels and slower rates of increase than the AuSable or Mackinaw State Forests.

Of the 71 stands/plantations (5,390 acres) less than ten years old surveyed, 40 stands (3,181 acres) were weeviled to some degree: 59% of the stands were weeviled, 35% were heavily weeviled (more than 20% of the trees weeviled in the current year), and 16% were moderately weeviled (6-20% of the trees weeviled in the current year).

Control measures were not undertaken since the problem was greatest in jack pine, where no economical control yet exists. MSU's entomology department and the DNR cooperately tested Orthene against the white pine weevil on jack pine; results are encouraging (for more details, see report of test, page 34). Populations are expected to increase in northeastern and north central Lower Michigan and remain high in northwestern Lower Michigan.

Table 6a. White pine weevil damage: district 5.

Co.	Twp.	Range	Sec.	Q.S.	% Damage	Acres
Trace Damage						
OTS	32N	1W	11	W½NW/ NWSW	0.9	120
MTM	29N	2E	2/ 3	NW, N½SW/ E½NE	0.9	105
Light Damage						
MTM	29N	1E	15	W½NW	42	56
MTM	31N	4E	7/ 18	S½SW/ NW, S½NE	5	210
Moderate Damage						
OTS	29N	1W	29	SWSE	9	40
OTS	32N	1W	10	SENE	7	40
MTM	32N	1E	22	N½S½	14	64
MTM	29N	1E	5	SWNW	13	20
MTM	31N	4E	20	E½NW	6	96
MTM	31N	4E	19	NW	11	76
CHE	35N	2W	27	SWNW	7	33
PRE	35N	3E	16	N½NE	11	78
Heavy Damage						
OTS	29N	1W	26/ 27	W½SW/ NESE	23	60
OTS	29N	1W	16	NE	68	63
OTS	29N	1W	10	S½N½, N½SW	34	121
OTS	32N	1W	3	SW	47	63
MTM	29N	2E	30	N½SW	42	64
MTM	29N	2E	31	NW	28	68
CHE	35N	2W	34	SWNW/ NWSW	23	80

Total Acres Damaged: 1537

OTS = Otsego
MTM = Montmorency
CHE = Cheboygan
PRE = Presquelsle

Table 6b. White pine weevil damage: district 7.

Co.	Twp.	Range	Sec.	Q.S.	% Damage	Acres
Trace Damage						
ROS	21N	4W	22	NE	0.5	80
Light Damage						
ROS	23N	1W	24	SE	4	160
ROS	21N	4W	29	N½NW	5	75
Moderate Damage						
CRA	26N	3W	2	NW	6	160
ROS	21N	4W	20	NE	6	27
OGE	24N	1E	17	SESE	14	40
CRA	27N	1W	15	N½SW	20	103
Heavy Damage						
ROS	24N	2W	22	SWSW	21	35
ROS	24N	2W	23	NW	23	80
CRA	26N	2W	1	NWSE/ SWNE	23	80
CRA	25N	4W	21	S½SW	26	80
ROS	23N	1W	25	SWSW	29	40
ROS	23N	1W	36	NWNE	32	40
ROS	24N	4W	5	E½NE	33	55
ROS	24N	2W	22	NWSE	35	20
ROS	24N	2W	17	NW	36	30
OGE	24N	1E	21	ENTIRE	53	300 Approx.
OGE	24N	2E	22	W½SW	60	60 Approx.
ROS	24N	4W	5	N½SE	60	65
OGE	24N	2E	4	S½NW	63	80

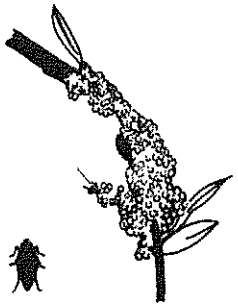
Total Acres Damaged: 1644

ROS = Roscommon
CRA = Crawford
OGE = Ogemaw

RED PINE SHOOT MOTH
(Dioryctria resinosella)

Damage was not as severe as in 1982. Although 85,000 acres of red pine were infested to some degree (map pg. 25), the area infested was smaller than in 1982. The infestation is expected to continue in high and moderate areas, although populations should become more moderate. Light and trace areas should decrease altogether, with infested acreage in 1984 even smaller than 1983.

SARATOGA SPITTLEBUG
(Aphrophora saratogensis)



Populations were down in plantations less than 10 years old. No damaging populations were detected (map pg. 25) possibly due to little snow cover and wide temperature fluctuations the previous winter. Although no significant losses occurred in monitored stands (less than 10 years old), 120 acres in Oscoda County were heavily damaged, with top kill and tree mortality in 19-year-old stands. Areas to be evaluated in 1984 are shown in the map on page 25. Table 7 shows the results of monitoring.

Table 7. Results of 1983 population monitoring for saratoga spittlebug (SSB).

County	Location	Species	Acres	Nymphs/Tree	Reevaluate In:
Benzie	26N,13W,S27	red pine	12	0.5 (e)	not needed
	27N,14W,S33	red pine	23	0.5 (e)	not needed
Crawford	27N,1W,S14	jack pine	15	0	1986
	27N,1W,S26	jack pine	177	0	1986
	25N,4W,S11	jack pine	17	0.15	1986
	25N,4W,S21	jack pine	16	0.10	1986
Gladwin	19N,2E,S28	red pine	20	0.56	1984
	18N,2E,S19	red pine	18	0.17	1985
	18N,2E,S27	red pine	12	1.9	1984
Lake	19N,12W,S3	red pine	20	1.0 (e)	1984
Kalkaska	25N,5W,S13	jack pine	87	0.10	1986
	27N,8W,S22	red pine	40	0	1986
Ogemaw	24N,1E,S31	red pine	48.5	0.026	1986
	23N,1E,S1	red pine	12	0.44	1984
	23N,2E,S29	red pine	23	0.98	1984
	23N,2E,S22		26	0.5	1984
Presque Isle	33N,2E,S24	jack pine	18	1.5	1984
	33N,2E,S18,19	red pine	26	0.2	1985
Roscommon	24N,1W,S31	red pine	30	0.59	1984
	24N,1W,S10	red pine	32	0.01	not needed
Wexford	24N,9W,S20	red pine	29	0.018	1986
	24N,9W,S5	red pine	12	0.7	1984
	24N,9W,S4	red pine	20	0.16	1985

(e) estimated

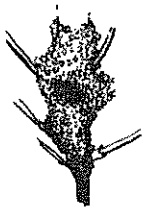
CHERRY SCALLOP SHELL MOTH
(Hydria prunivorata)

Some degree of damage was found on choke, wild, and black cherry trees throughout the region. The moth heavily defoliated 7,820 acres (map pg. 26). Although the defoliated area was smaller than in 1982, the severity of defoliation was greater. Some tree mortality occurred in trees that had been hit both years. The major loss will be reduced food for wildlife, as most of the trees have no commercial timber value. Heavy defoliation in the mapped area should continue in 1984, with increased tree mortality.

OAK SKELETONIZER
(Bucculatrix ainsliella)

Oak skeletonizer was found throughout the region, with damage being more severe and widespread than in 1982; 132,840 acres had heavy defoliation. In the areas shown on the map (pg. 27), 50 to 100% of the leaves were skeletonized. Although no permanent tree damage was expected from the defoliation, it will continue to stress the trees, thus leading to secondary pests (two-lined chestnut borer, Armillaria, etc.) that could kill the oak trees. Damage in 1984 may increase, but parasites soon should be working to control the problem.

PINE SPITTLEBUG
(Aphrophora parallela)

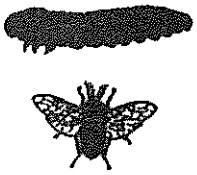


Populations of and damage by the pine spittlebug were significantly less than in 1982. Small infestations and single tree damage in ornamental and forest plantations were found on Scots, jack, and white

pine trees throughout the region, killing some trees. Less severe damage resulted in flagging.

Mortality in forest situations was always less than one acre and usually at the edge of a stand. Homeowners became very concerned when their individual trees were killed, and they tried to control the spittlebug in several ways ranging from washing them off with water from a hose under pressure to spraying Sevin.

REDHEADED PINE SAWFLY
(Neodiprion lecontei)



Two counties reported damage: the 100-square-mile area in Wexford County (map pg. 27) which is a continuing problem area, and a 10-acre infestation in a 20-acre red pine stand in Emmet County. Damage included tree mortality in both locations and top kill in Emmet County.

Pheromone traps were used to catch adult male moths (map pg. 28). No colonies were found in follow-up surveys in these locations. Pupal collections in Wexford County showed that parasites and predators had attacked almost all cocoons, and polyhedral virus was found in many cocoons. Therefore, populations should be down in 1984 in Wexford County, but may rise in Emmet County (map pg. 28).

REDHUMPED OAKWORM
(Symmerista canicosta)

The redhumped oakworm heavily defoliated 2,000 acres of oak trees in Benzie and Kalkaska counties (map pg. 29). Many trees were completely defoliated. No lasting tree damage is expected; however, defoliation is expected to intensify and spread in 1984.

OAK WEBWORM
(Archips fervidanus)

Oak webworm was detected on 14,400 acres of oak trees in Clare, Ogemaw, and Roscommon counties (map pg. 30). Most trees had multiple nests per tree; however, defoliation was 20% per tree or less. No significant tree damage was expected, as it is merely a stress agent on trees suffering from a variety of stressors. Defoliation may increase in 1984.

OAK WILT
(Ceratocystis fagacearum)

Oak wilt continued to be a problem in Roscommon County (map pg. 29). Most of the epicenters (1200 total acres), which are in home landscapes, had several dead trees. Oak wilt has been a long-time problem in Roscommon County, and levels of damage have neither increased nor decreased recently. Because it spreads slowly and claims few trees every year, oak wilt is not a pressing problem. Homeowners are given advice on how to control the problem on their trees, but no area control program is necessary.

MAPLE DECLINE/WATER STRESS

Many single, mature maple trees suffered from water stress throughout the region. Water-stressed trees were found more often in the northern and northwestern sections, along the shores of the Great Lakes, and along roadsides. Symptoms ranged from leaf water stress to branch, crown, and tree mortality. Mortality was high in cities and in individual ornamental trees. In forests, mortality was not significant. Mortality may increase in 1984 if droughty conditions continue.

SCLERODERRIS CANKER
(Gremmeniella abietina)

Plantations 10 years old and younger were risk-rated for susceptibility to Scleroderris canker (map pg. 31) by ranking stand conditions within several different categories. Each condition was assigned a coded value, higher values indicating higher potential risk of infection. A final risk rating for the plantation was computed by taking the sum

of the values for each category. These categories, with conditions listed from most to least susceptible, are:

1. stand history
   - previously infected: 2
   - not previously infected: 1
2. stand location
   - low, wet, poorly drained air flow: 2
   - high, dry, well drained air flow: 1
3. species
   - % red pine x 3 = ___
   - % jack pine x 2 = ___
   - % white pine x 1 = ___
   - Total ___
4. stand size
   - sapling: 3
   - pole: 2
   - sawtimber: 1
5. direction to nearest infested stand
   - southwest: 2
   - northwest: 1

Risk rating:

low	1-9
moderate	10-35
high	36-72

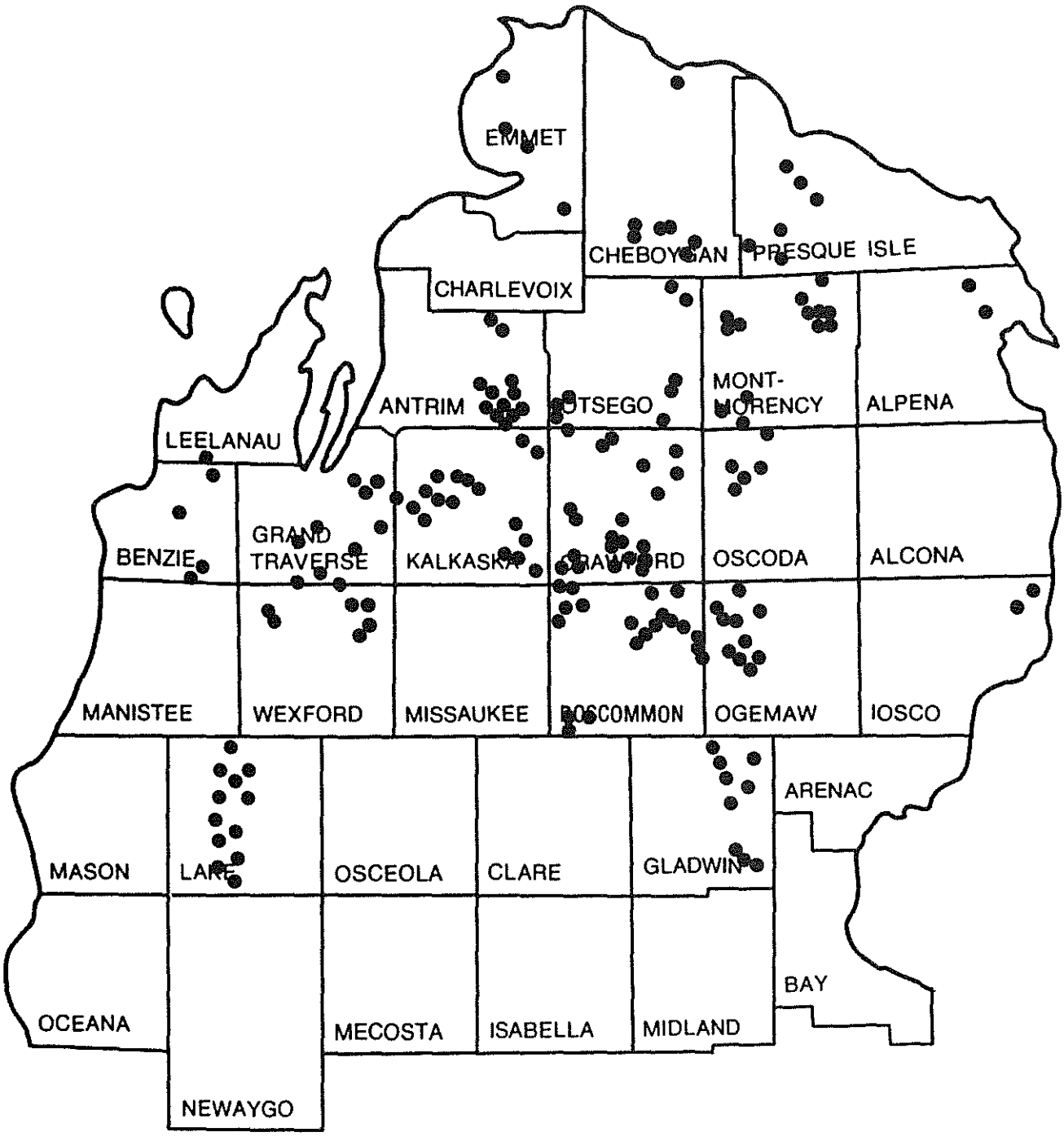
OTHER PEST PROBLEMS: 1983
Lower Peninsula

Pest	Host	Location and Comments
Insects		
Aspen Leafroller Complex *(Choristoneura conflicta)* (*Anacampsis* sp.)	Aspen	Throughout region; light infestations.
Birch Leaf Mining Sawfly *(Fenusa pusilla)*	White Birch	Throughout region
Eastern Tent Caterpillar *(Malacosoma americana)*	Cherry	Throughout region; light infestations.
European Pine Sawfly *(Neodiprion sertifer)*	Pines	Throughout region
Fall Cankerworm *(Alsophila pometaria)*	Oak	Ogemaw County
Imported Willow Leaf Beetle *(Plagiodera versicolor)*	Willow	Roscommon County
Introduced Pine Sawfly *(Diprion similis)*	Red Pine	Otsego County
Maple Leaf Cutter *(Paraclemensia acerifoliella)*	Maple	Grand Traverse County
Pine Bark Beetles *(Ips sp.)*	Jack & Red Pine	In small spotty infestations scattered throughout budworm damaged stands of jack and red pine.
Pine Chafer *(Anomala oblivia)*	Jack, Red, White & Scots Pine	Throughout region
Pine Gall Rust	Jack Pine	Throughout region (map pg. 30)
Pine Needle Sheath Miner *(Zellaria haimbachi)*	Jack Pine	Roscommon County
Pine Root Collar Weevil *(Hylobius radicus)*	Red, Jack, Austrian Scots Pine	Throughout region (map pg. 32)
Pine Tortise Scale *(Toumeyella numismaticum)*	Jack Pine	Lake Huron counties

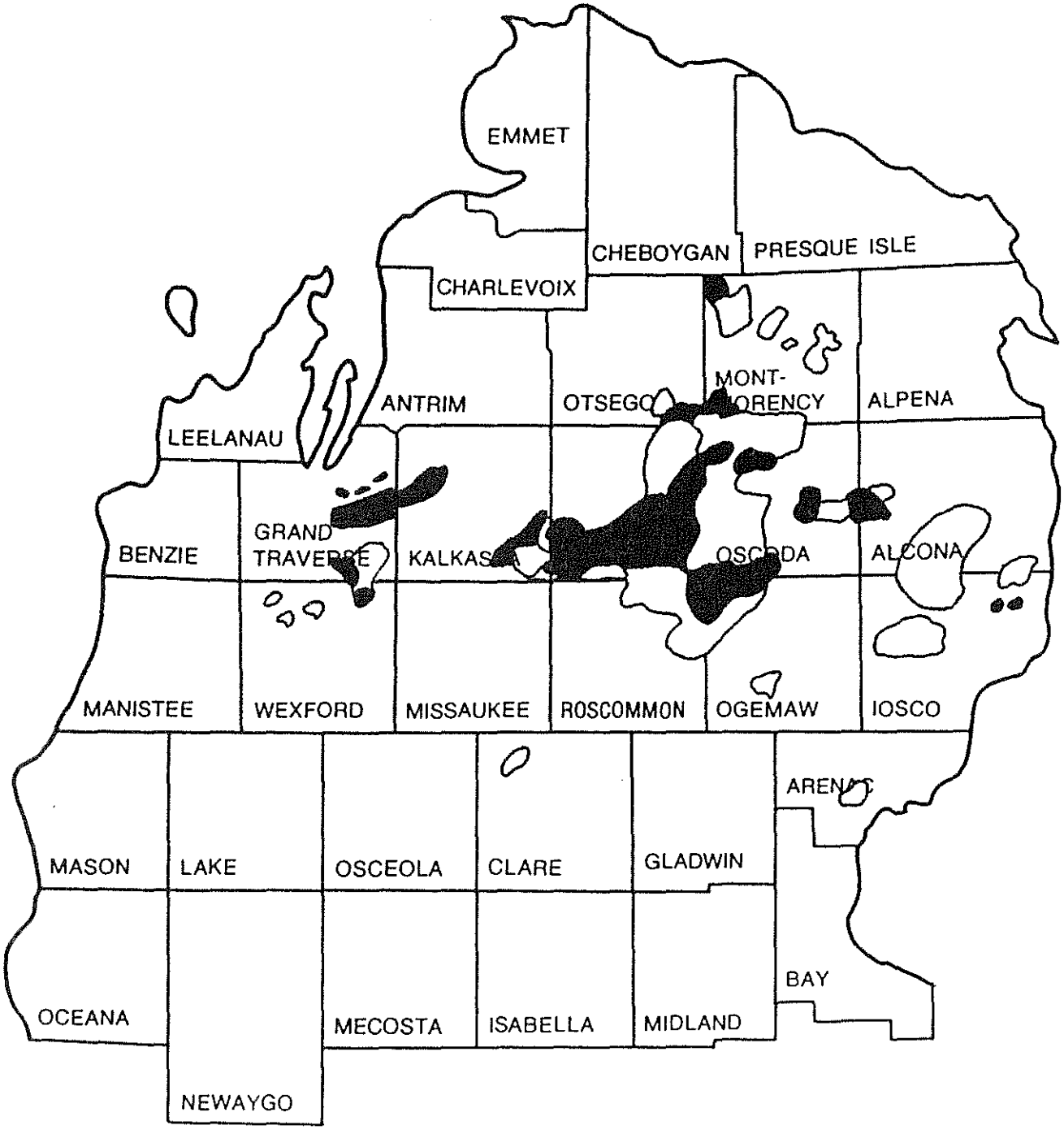
Other Pest Problems: 1983 (continued)

Pest	Host	Location and Comments
Spruce Budworm *(Choristoneura fumiferana)*	Balsam Fir, Spruce	Kalkaska & Missaukee counties had heavy infestations in a few small Christmas tree stands.
Sycamore Lace Bugs *(Corythucha ciliata)*	Sycamore	Wexford County
Yellowheaded Spruce Sawfly *(Pikonema alaskensis)*	White Spruce	Oscoda County
Diseases		
Armellaria Root Rot *(Armellaria* sp.)	Jack & Red Pine	Killing a large percentage of the timber that is still dying in heavy budworm damage areas.
Scleroderris Canker *(Gremmeniella abietina)*	Red Pine	No new infestations (map pg. 31)
Marssonina Leaf Spot *(Marssonina* spp.)	Aspen	Throughout region
Other		
Drought Damage	Jack Pine	Throughout region on young trees.
Frost Damage	Jack Pine	Scattered throughout region.

PLANTATIONS MONITORED FOR ALL PESTS
(10 Years Old and Younger)



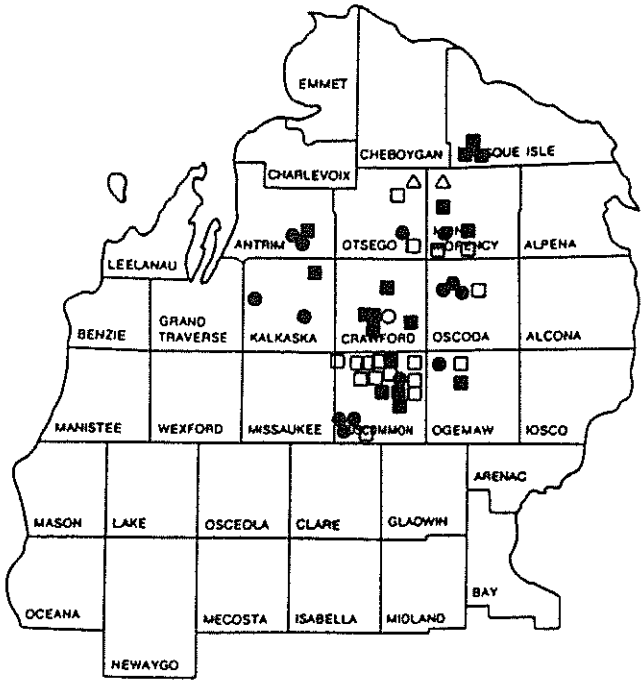
JACK PINE BUDWORM
Stand Conditions



● Level I: 35% mortality in current year; top kill and deformity; 90% growth loss in current year.

○ Level II: less than 10% mortality in current year; top kill and deformity; 55% growth loss in current year.

JACK PINE BUDWORM

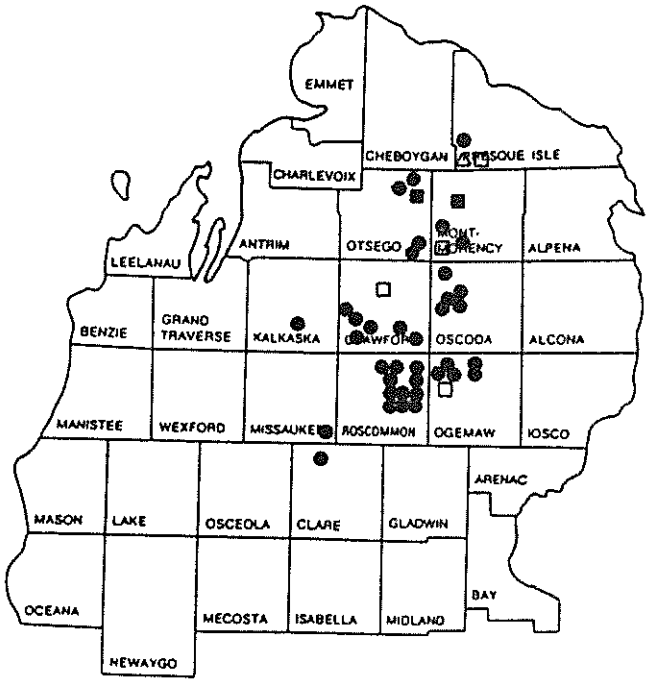


Early Larval Survey 1983
(plantations 10 years old and younger)

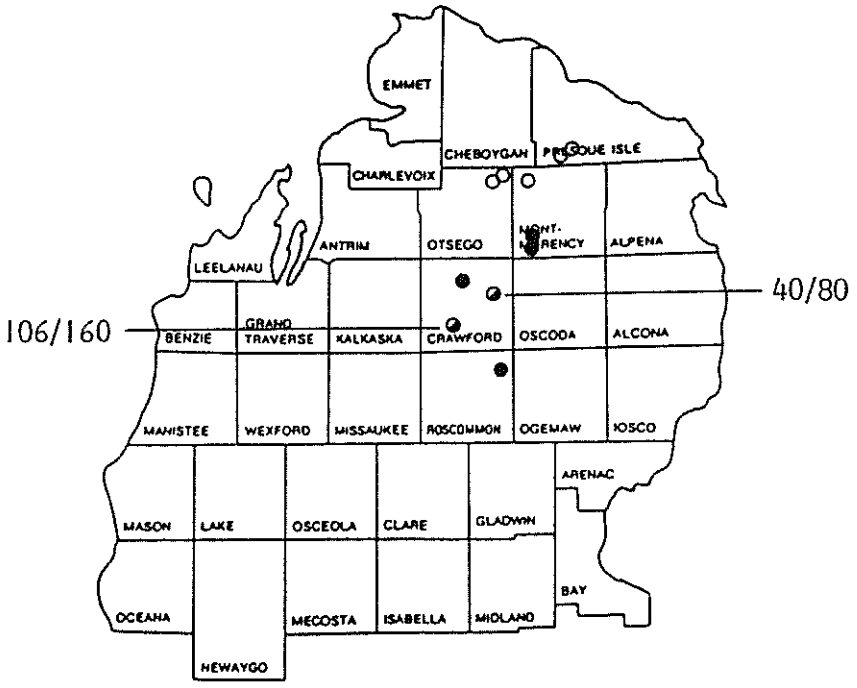
- ○ no larvae present
- ● 1 - 9 larvae/30 tips
- □ 10 - 16 larvae/30 tips
- ■ 17 - 22 larvae/30 tips
- △ 23+ larvae/30 tips

Pre-Spray Larval Survey
(plantations 10 years old and younger with early larval counts of 12 or more)

- ○ no larvae present
- ● 1 - 2.4 larvae/15" sample
- □ 2.5 - 3.9 larvae/15" sample
- ■ 4.0 - 5.0 larvae/15" sample
- △ 5.1+ larvae/15" sample



JACK PINE BUDWORM

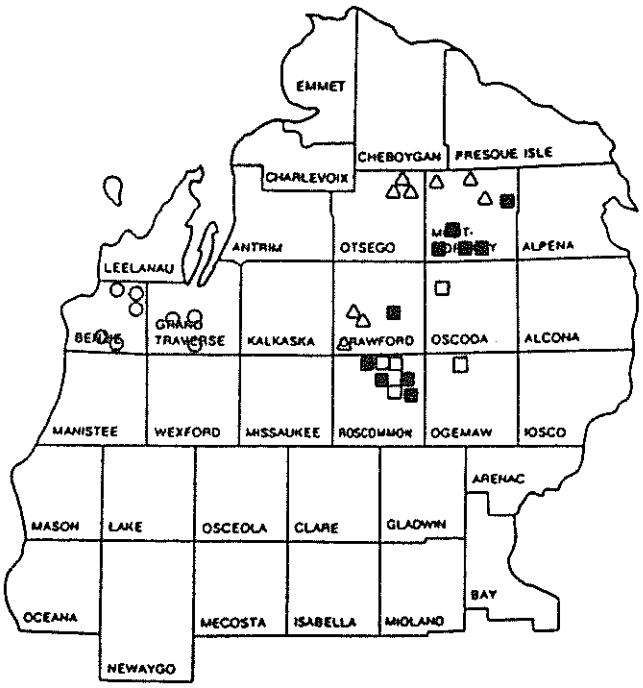


Spray Project 1983

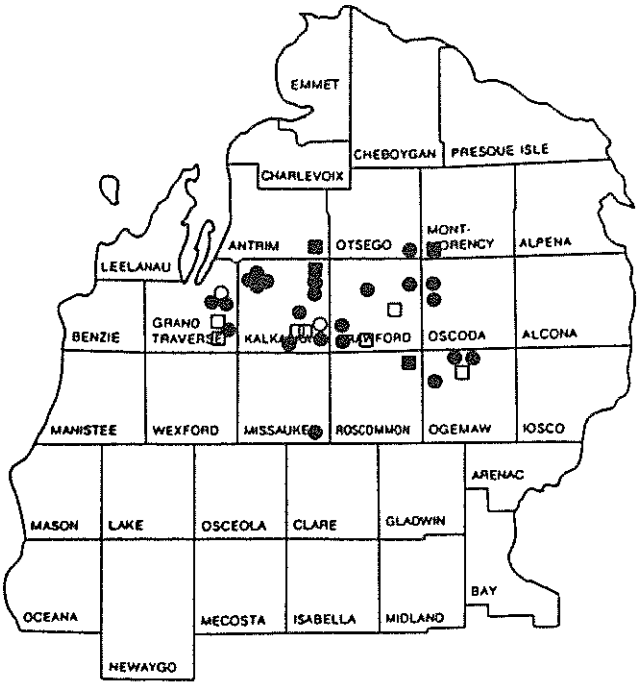
- areas sprayed
- areas not sprayed
- areas partially sprayed

Damage Survey 1983
(plantations 10 years old and younger)

- no defoliation
- trace: 1 - 5% defoliation
- light: 6 - 15% defoliation
- moderate: 26-50% defoliation
- high: 51 - 75% defoliation



JACK PINE BUDWORM

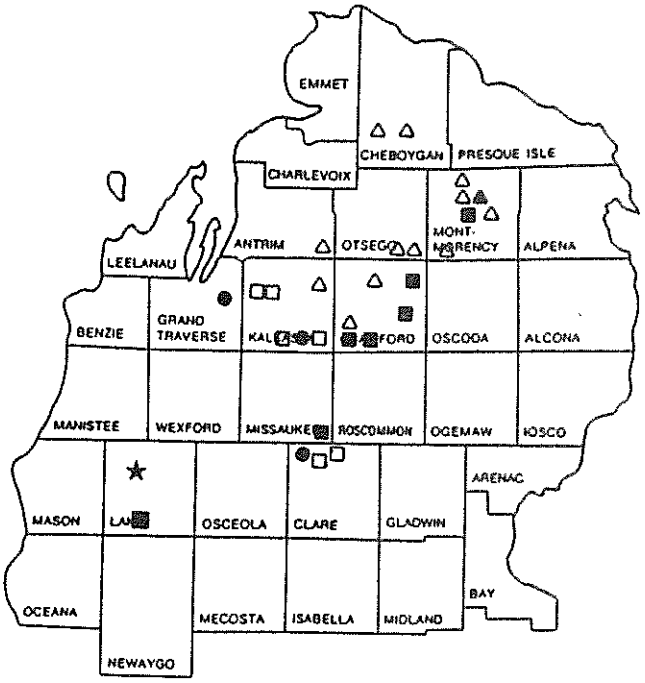


Early Larval Survey
(permanent sample plots)

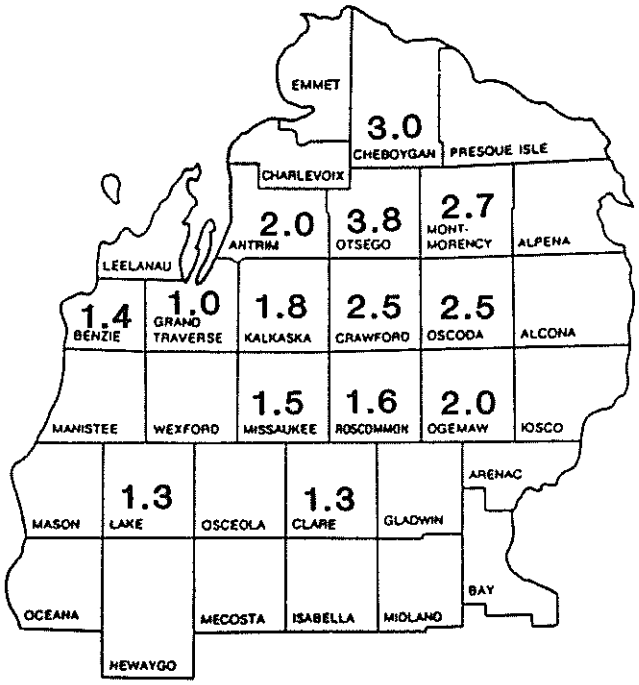
- ○ no larvae present
- ● 1 - 9 larvae/30 tips
- □ 10 - 16 larvae/30 tips
- ■ 17 - 22 larvae/30 tips
- △ 23+ larvae/30 tips

Damage Survey
(permanent sample plots)

- ○ no defoliation
- ● trace: 1 - 5% defoliation
- □ light: 6 - 15% defoliation
- ■ moderate: 16-25% defoliation
- △ high: 26 - 50% defoliation
- ▲ severe: 51 - 75% defoliation
- ★ extreme: 76+% defoliation



JACK PINE BUDWORM

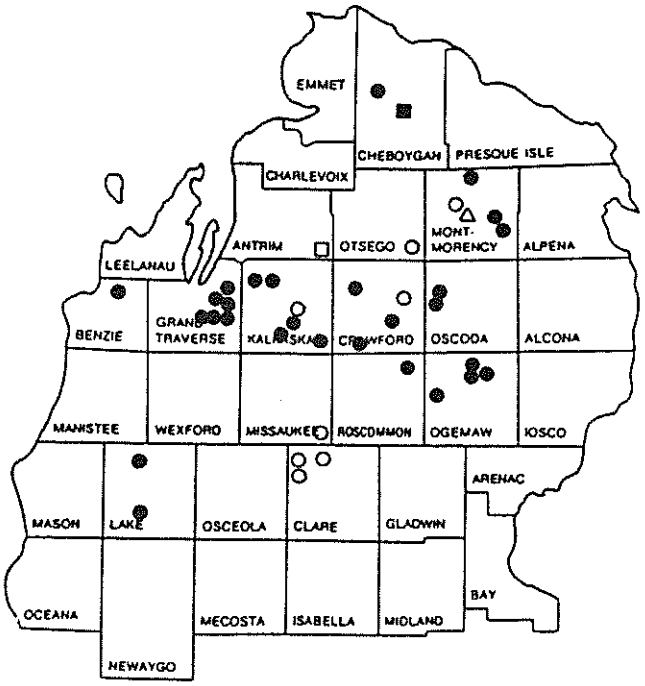


Pupal Survey by CCMS
(15-minute search of 15" branch samples)

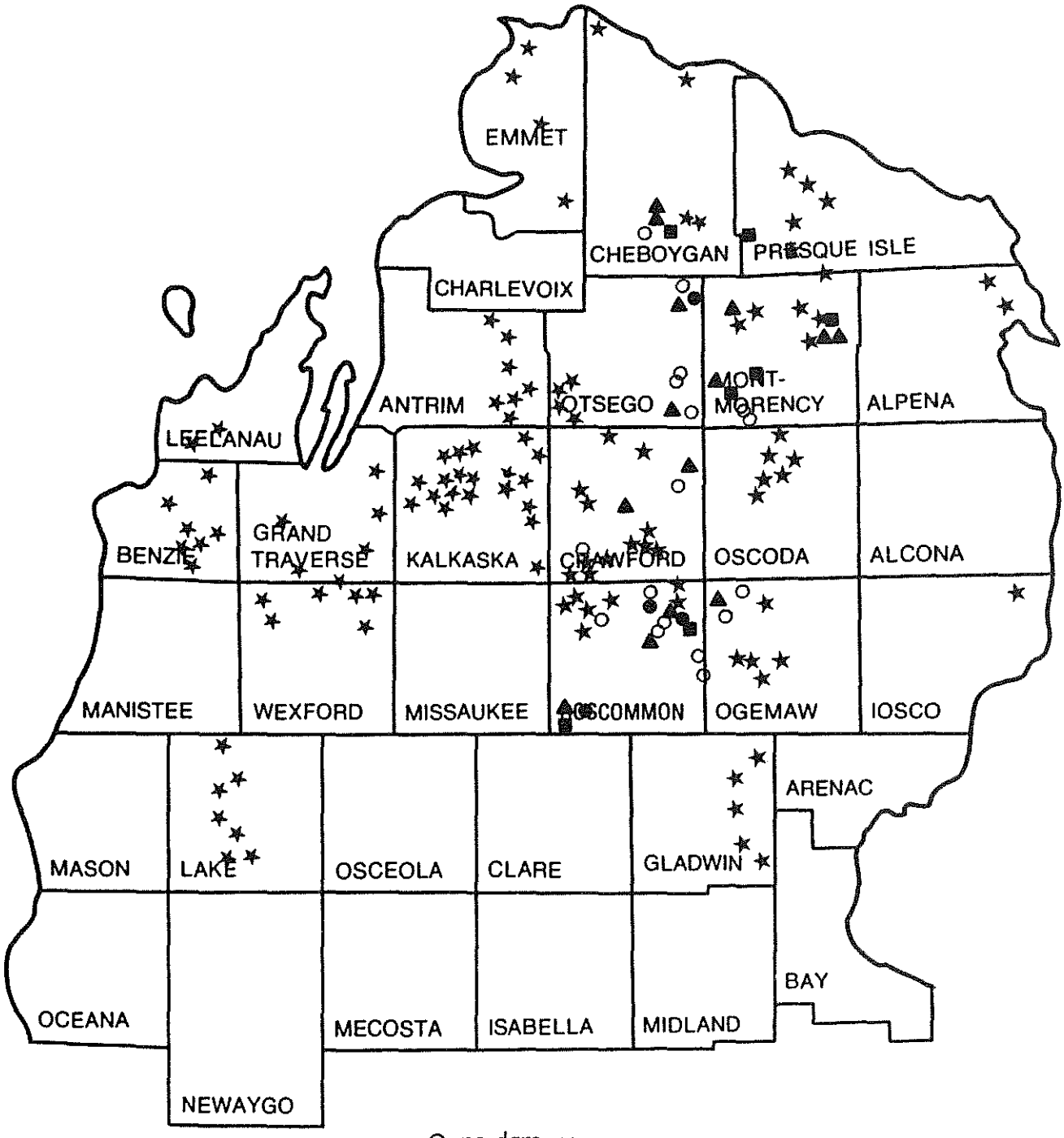
Damage rating scale of 1 - 5

Late Larval Survey
(permanent sample plots)

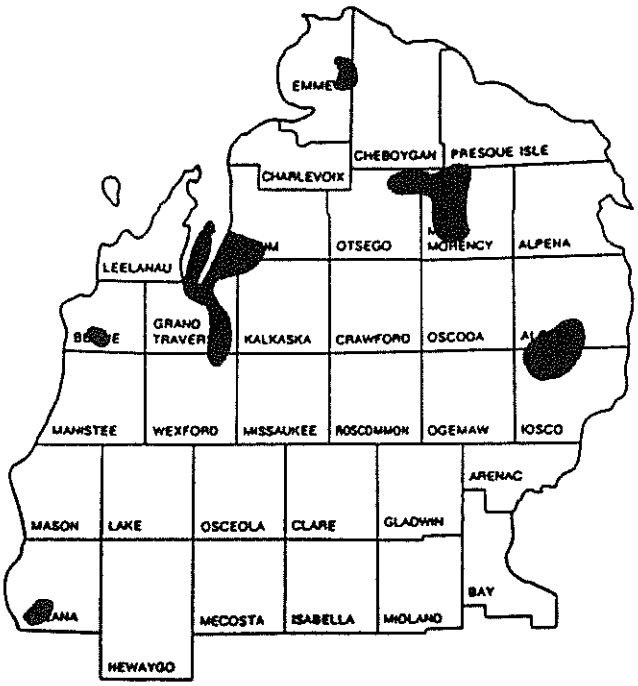
- ○ no larvae present
- ● 1 - 2.4 larvae/15" sample
- □ 2.5 - 3.9 larvae/15" sample
- ■ 4.0 - 5.0 larvae/15" sample
- △ 5.1+ larvae/15" sample



WHITE PINE WEEVIL
(Plantations 10 Years Old)



○ no damage
● few: < 1%
■ common: 1 - 5%
▲ abundant: 6 - 20%
★ extreme: 21+%

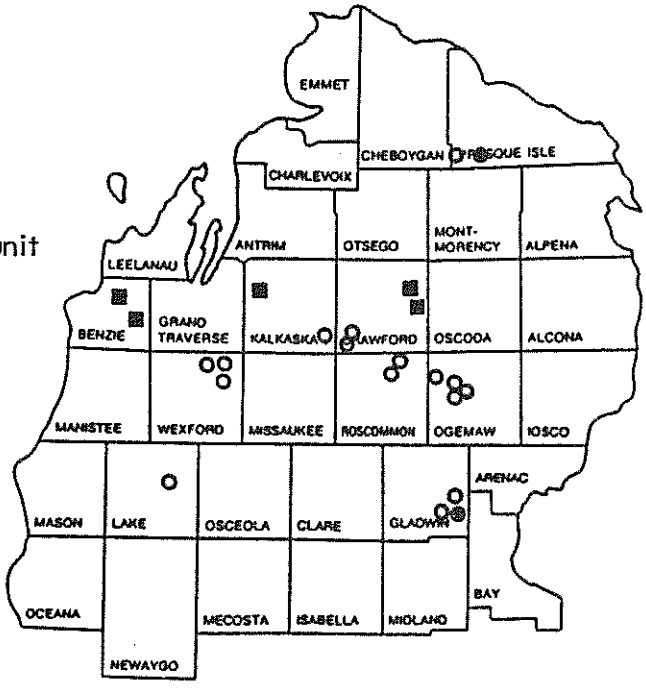


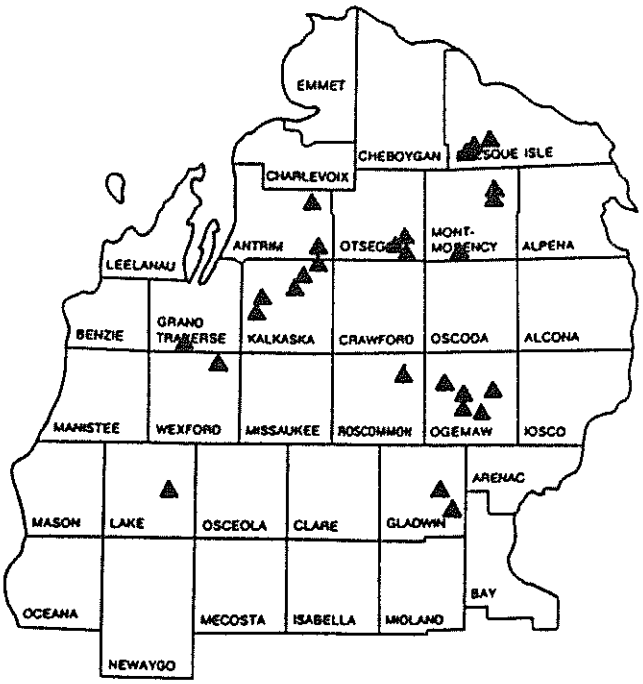
RED PINE SHOOT MOTH

- Moderate to high damage (16% of tips infested)

SARATOGA SPITTLEBUG

- o low: 0 - 1.0 nymphs/tree unit
- ● moderate: 1.01 - 2 nymphs/tree unit
- ■ no spittlebug present



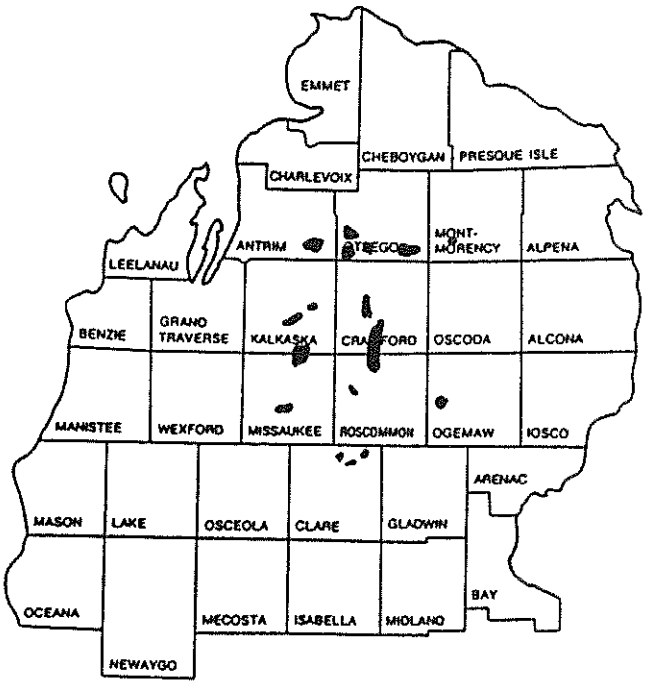


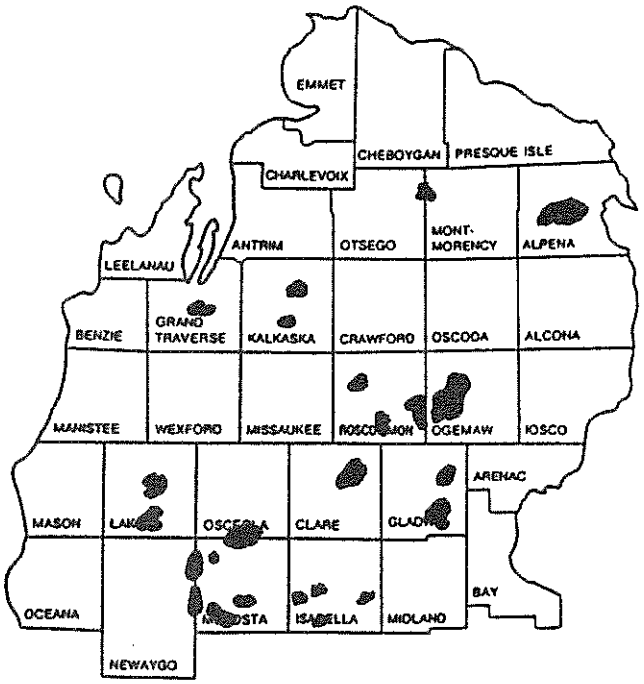
SARATOGA SPITTLEBUG

▲ Areas to be evaluated in 1984

CHERRY SCALLOP SHELL MOTH

■ incidence



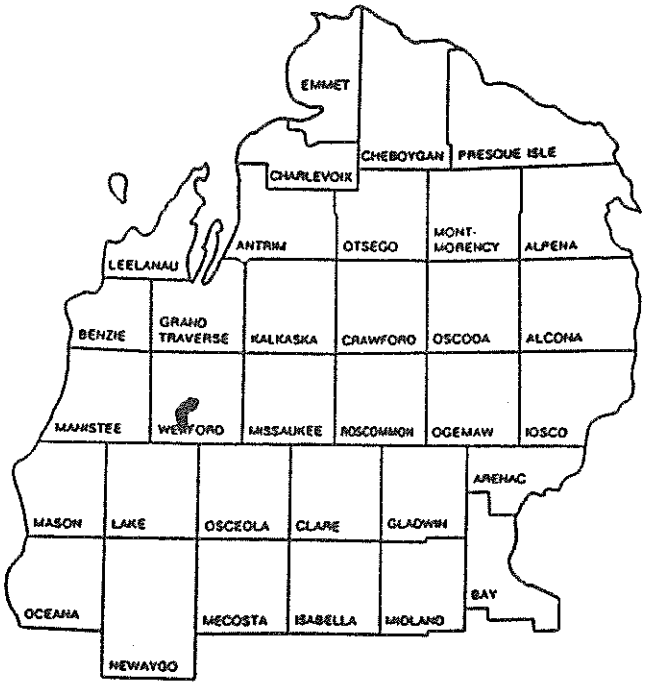


OAK SKELETONIZER

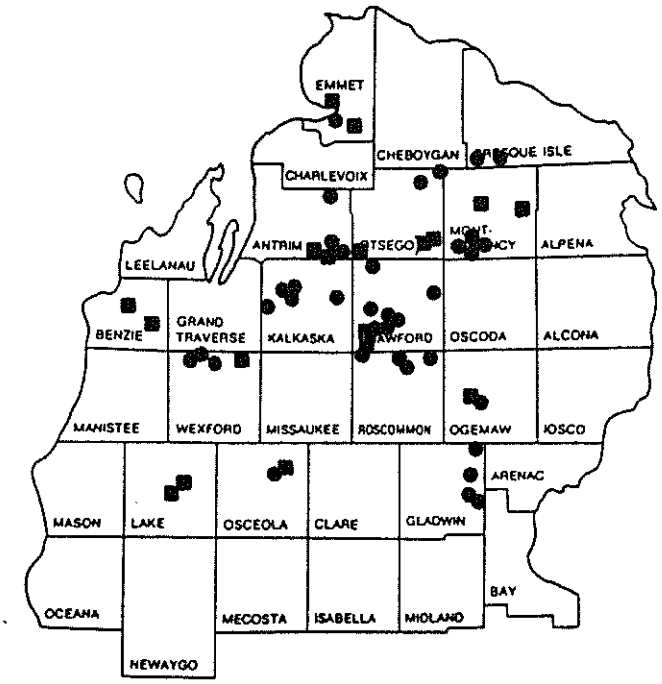
- incidence

REDHEADED PINE SAWFLY

- area of damage



REDHEADED PINE SAWFLY

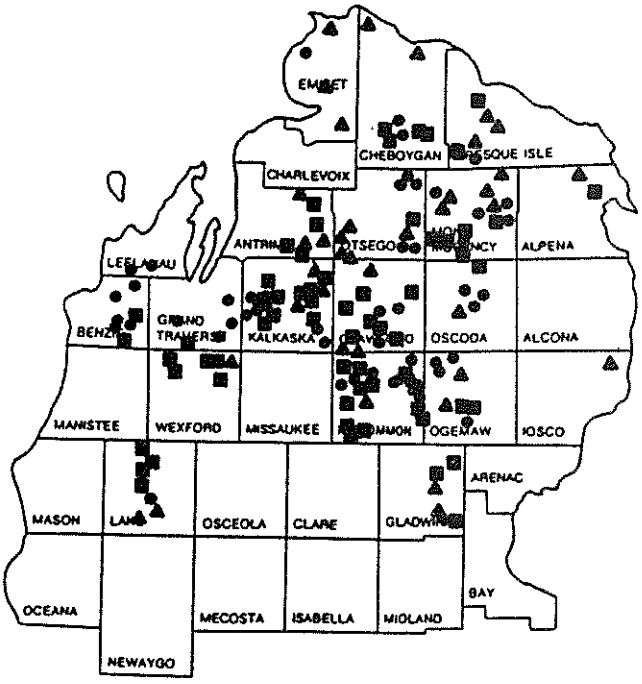


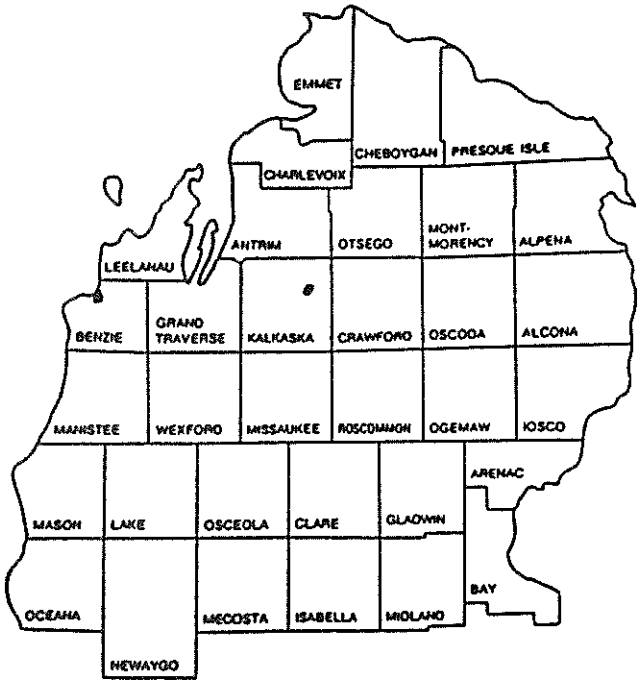
Adult Trapping Results

- ■ positive
- ● negative

Risk Rating:

- ▲ high: site resistance class III
- ■ moderate: site resistance class II
- ● low: site resistance class I



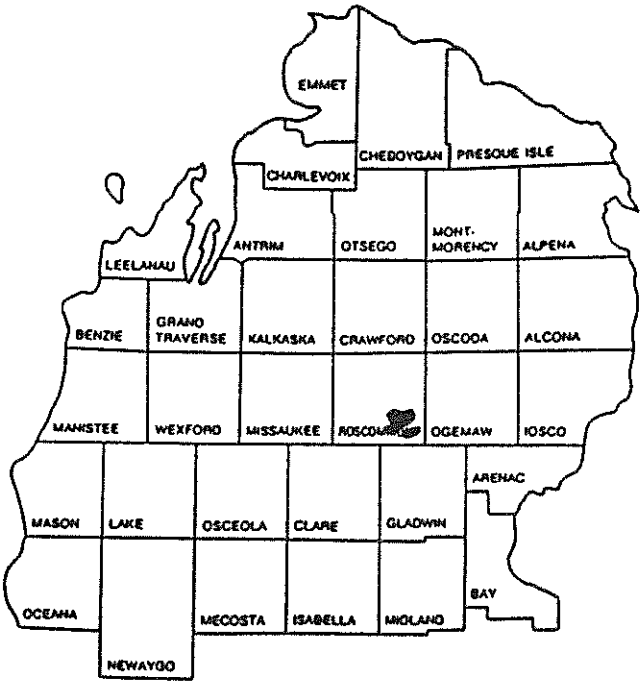


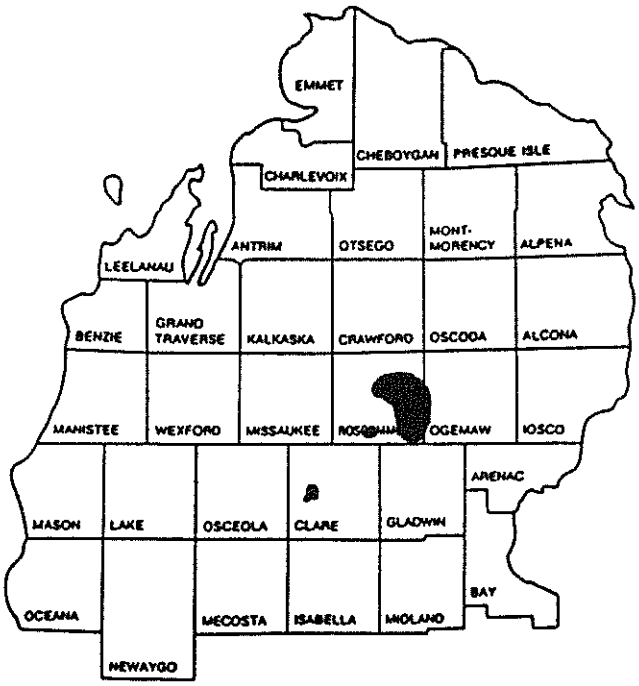
REDHUMPED OAKWORM

■ incidence

OAK WILT

■ incidence





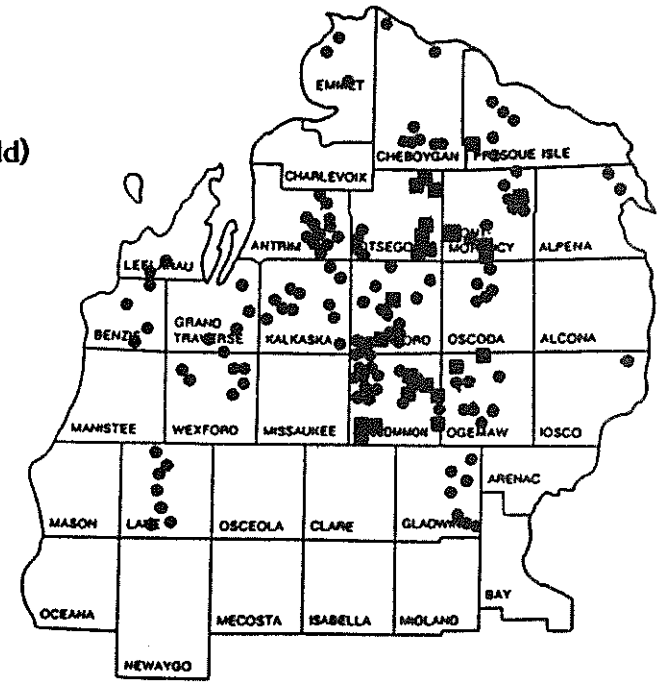
OAK WEBWORM

■ incidence

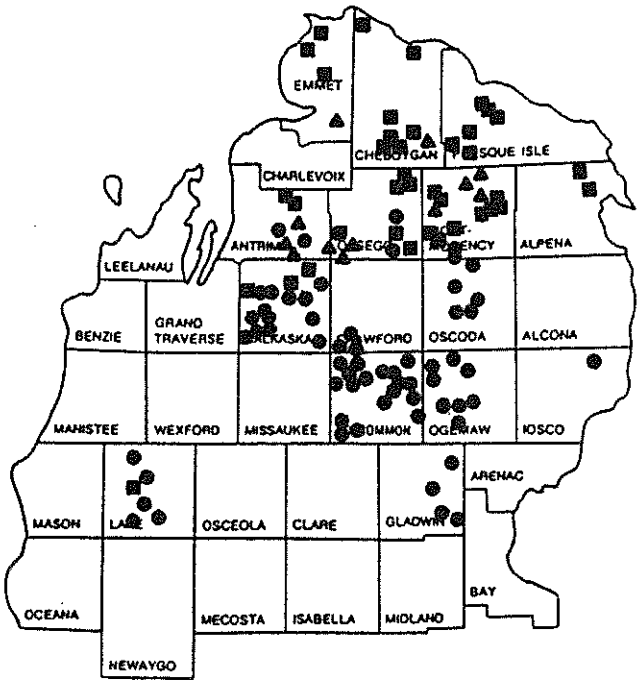
PINE GALL RUST
(Incidence in Plantations Less than 10 Years Old)

■ positive

● negative



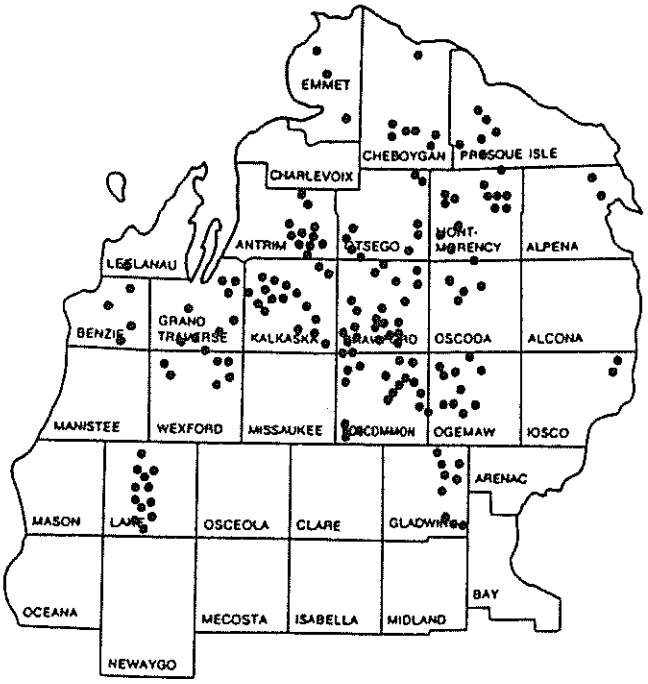
SCLERODERRIS



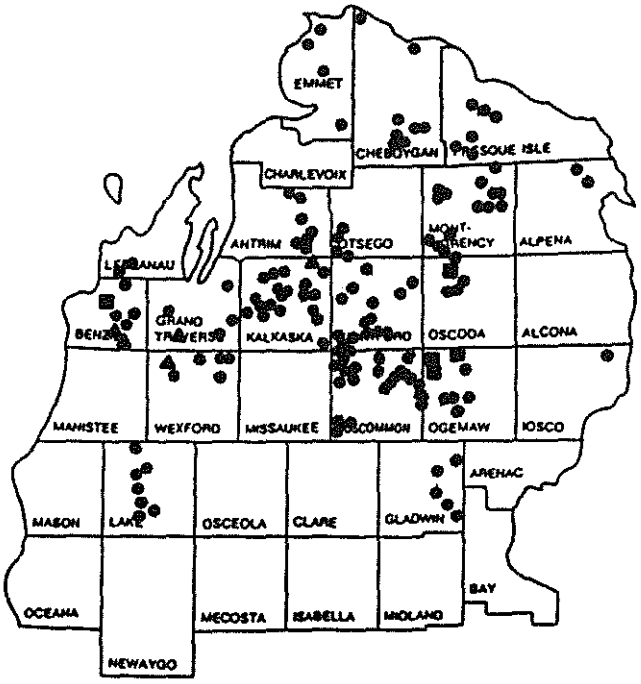
Risk Rating:

- ▲ high: site resistance class III
- ■ moderate; site resistance class II
- ● low: site resistance class I

- ● plantations surveyed
  no disease detected



PINE ROOT COLLAR WEEVIL
(Plantations Less than 10 Years Old)

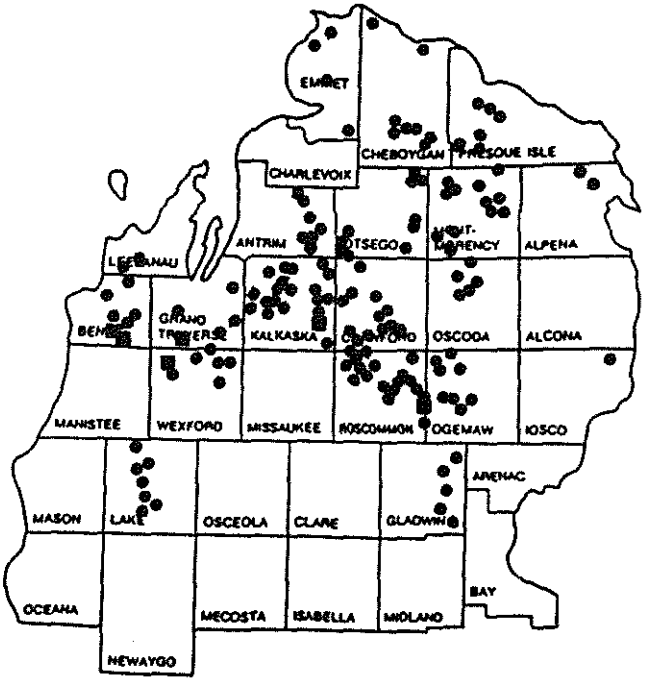


Risk Rating:

- ▲ high: site resistance class III
- ■ moderate: site resistance class II
- ● low: site resistance class I

Damage

- ■ positive
- ● negative



Special Reports

DISEASE PROBLEMS: LOWER PENINSULA
(S. Perry, MSU)

The unusually mild winter of 1983, followed by zero degree temperatures in mid-March, caused extensive needle damage on white and blue spruce.

The cool, rainy spring weather led to a severe outbreak of anthracnose *(Gloesporium* sp.) on sycamore. Anthracnose also was devastating to white oak and maples; ash was attacked, also, but to a lesser extent.

Diplodia tip blight *(Diplodia pinea)* continued to be a landscape problem on Austrian and Scots pines.

Other diseases related in severity to the wet, spring weather were cedar-apple rust *(Gynosporangium* sp.), apple scab *(Venturia inaequalis),* and juniper blight *(Phomopsis* sp.).

The hot, dry summer brought on many cases of the wilt diseases, such as Dutch elm disease *(Ceratosystis ulmi)* and Verticillium wilt *(Verticillium alboatrum).* Cytospora canker on blue spruce was seen frequently.

As the growing season ended with dry weather, evergreens may have had inadequate soil moisture, which may result in problems in 1984.

ORNAMENTAL TREE PESTS
(G. A. Dunn, MSU)

Based on the records of shade tree and ornamental pests diagnosed for the Lower Peninsula at the MSU Diagnostic lab, the following trends were seen.

1. Pests were less prevalent than in preceding years, including the European pine sawfly *(Neodiprion sertifer)* and the elm leaf beetle *(Pyrrhalta luteola).*
2. Pests at typical levels of prevalence included Eastern spruce gall adelgid *(Adelges abietis),* hemispherical scales, gall-inducing insects and mites, birch leaf miner *(Fenusa pusilla),* and bronze birch borer *(Agrilus anxius).*
3. Pests more prevalent than in previous years included the Cooley spruce gall adelgids *(Adelges coolyi),* arborvitae leafminer *(Argyresthia thuiella)* and oak skeletonizer *(Bucculatrix ainsliella).*

GYPSY MOTH PARASITE WORK
(R. J. Priest, MDA)

A parasitic wasp, *Rogas lymantriae* Watanabe, new to the United States was received from the U.S. Forest Service this year. Approximately 4,000 wasps were field-released in June at a single site in Gratiot County. This braconid wasp attacks early instar larvae, resulting in mummified caterpillars. Adults of the second generation were recovered in July. *R. lymantriae,* being double-brooded, require an alternate host, possibly the whitemarked tussock moth. Next year, this site will be surveyed to determine wintering success.

In 1982, the gypsy moth egg parasite, *Ooencyrtus kuvanae* (Howard), was released at 12 sites in mid-Michigan. This year, each of those sites were surveyed to detect surviving populations. Ooencyrtus adults were recovered at 11 of these sites.

The property owner of one site stated his intent to treat in 1984. To avoid the loss of all parasites there, after eggs were laid, they were collected and moved to a new site where the parasites could hatch and become established. The exposed egg masses were recovered in December and destroyed.

CCMS: GYPSY MOTH TRAPPING
(T. Prokrym and H. Russell, MSU)

In 1983, the Cooperative Crop Monitoring System (CCMS) in conjunction with the MDA and USDA/APHIS continued surveying for gypsy moths throughout the state. This year, CCMS processed data on 16,420 traps.

Data were collected from delta and milk carton pheromone traps placed in 72 Michigan counties, as compared to 46 traps in 1982. Trap locations were determined by the MDA and the USDA/APHIS. Personnel from these agencies were responsible for setting, recovering, evaluating, and recording traps and trap catch information.

Trap densities varied with the intent or purpose of the trapping. To detect gypsy moths, traps were set at a density of 12 traps per township or one trap per three square miles. To delimit known populations, traps were set at densities of 4 to 32 per square mile. To monitor areas that had been chemi-

cally treated for gypsy moth control, traps were set at 15 to 32 per square mile.

In 1983, permanent trap sites were introduced in Bay, Gratiot, Isabella, Mecosta, Midland, and Saginaw counties. These traps were set at densities of 1 to 8 per square mile to establish collecting information from the same locations each year.

Information recorded for each trap was: (1) trap location: county, township, section, quadrat; (2) set out and recovery dates; (3) trap status: replaced, lost, not set due to lack of suitable hosts; and (4) number of gypsy moths captured.

Figures 1 and 2 are examples of the CCMS summarizations of the collected data.

GYPSY MOTH MANAGEMENT PROGRAM
(J. Dreves, MDA)

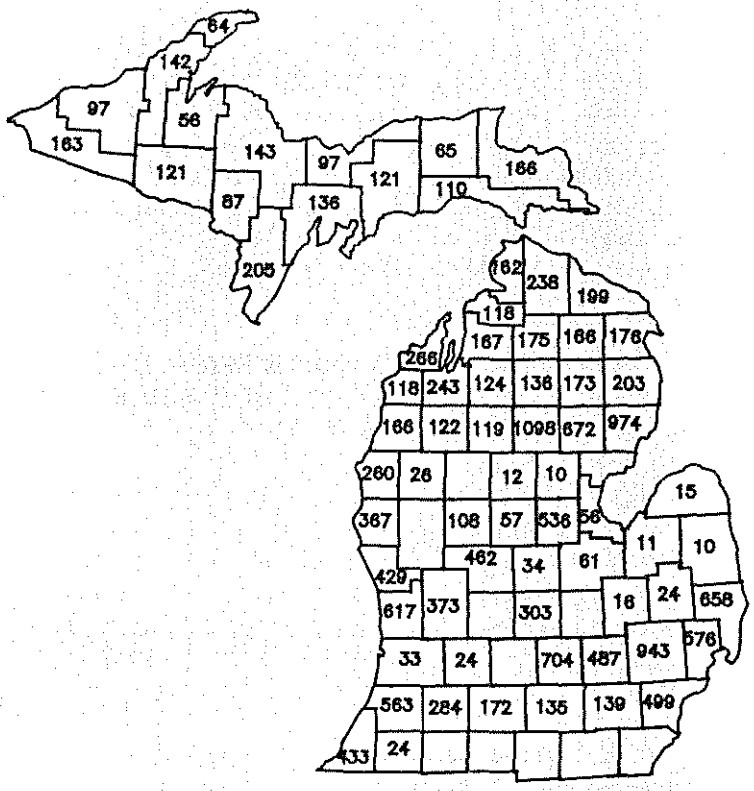
The Michigan Department of Agriculture cooperates with the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, and the USDA Forest Service to manage the gypsy moth in Michigan.

Each year, the state traps for gypsy moth to detect new infestations outside of the infested counties and to delimit previously isolated finds. In 1983, 17,960 traps were set. Of the areas where gypsy moth was found, only 2,179 acres in Van Buren, Livingston, Oakland, Kalamazoo, and Muskegon counties were to be treated.

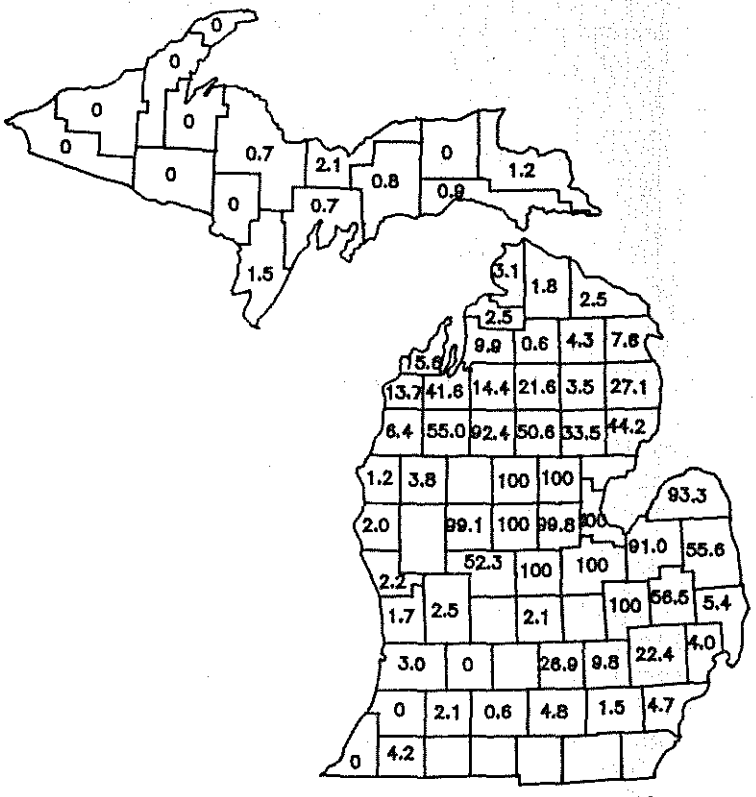
During the summer, the MDA initiated a pilot program for monitoring gypsy moth populations to see what the populations do under normal circumstances. The program includes a uniform pheromone trap survey throughout the region and the release of exotic parasites. In 1984, alternatives for controlling gypsy moth will be evaluated for possible use in the program.

CONOPHTHORUS CONE BEETLE STUDY
(W. J. Mattson, J. R. Miller, and B. Tabashnik, MSU)

A conceptual model was developed to understand the key processes in the cone beetle's finding behavior. We determined that beetles alight randomly on tree branches, apparently not orienting to host odors.



Gypsy moth pheromone trapping: number of traps set.



Gypsy moth pheromone trapping: proportion of positive traps.

The cone beetles, therefore, appear to be less host-specific than previously thought. For example, red pine cone beetles may attack host trees other than red pine, like jack pine and white pine. In most red pine stands, the red pine cone beetle is competitively superior to any other cone insect. Hence, it is the dominant pest in nearly every stand.

BALSAM FIR AND WHITE SPRUCE RESISTANCE TO SPRUCE BUDWORM (W. J. Mattson, MSU)

Resistance of balsam fir and white spruce to spruce budworm was studied at the experimental provenance forest at the Kellogg Biological Station. This first year's work showed a clear difference among tree seed sources in their ability to support insects. Support includes the growth rate and fecundity of the insect.

The Minnesota seed sources for balsam fir were best (least resistant) in all variables for supporting spruce budworm. Quebec, New Brunswick, and Maine white spruce seed sources were best able to support spruce budworm; therefore, they are most susceptible to spruce budworm.

TARNISHED PLANT BUG ON POPLAR (L. Wilson and L. Moore, USDA Forest Service)

The tarnished plant bug is normally an agricultural pest that attacks over 100 types of plants. However, three years ago in Wisconsin, it was found attacking poplar trees. In 1983, it caused very heavy damage in one nursery in Manistee—a clonal nursery owned by the Packaging Corporation of America. Here it was exceptionally heavy on the clone "Wisconsin 5"; 83% of the clones were attacked—twice as much as any other clone.

The pest seriously damages 1-and 2-year-old whips. Feeding by the pest causes large, necrotic galls (1 to 1½ inches) to form on the stem. Often the stem breaks over at this point of damage, causing the tree to crook or resprout.

Research in 1984 will study the behavior of the insect to find out why it attacks poplar. "Wisconsin 5" has particularly rough bark, which may be one reason for it being more heavily attacked.

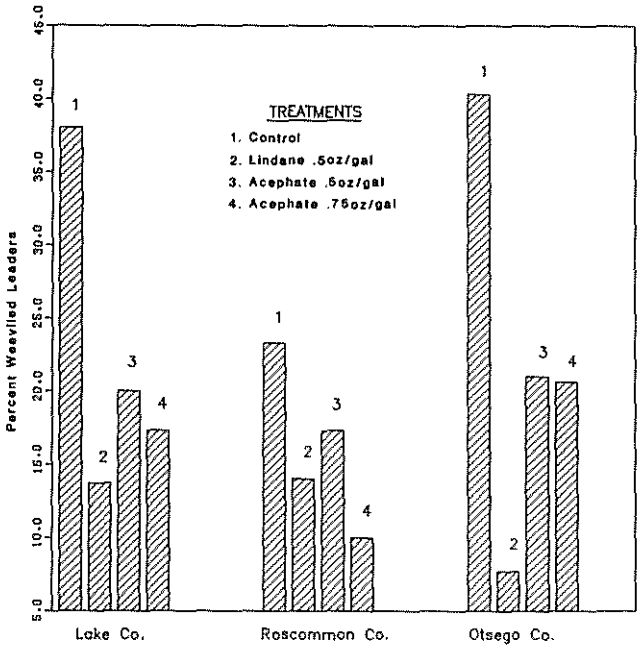
RESEARCH AT THE FOREST ENTOMOLOGY LAB AT MSU

Plantation Decline Caused by the White Pine Weevil (F. J. Sapio, G. A. Simmons, and R. L. Murray)

We began developing and testing a model for projecting the decline of a jack pine plantation over time as caused by the white pine weevil. By using the binomial distribution, the model can project the proportion of trees weeviled X times over a period of years. By coupling this degrade model with a growth and yield model and economic analysis, an economic level of weevil damage can be derived for jack pine plantations. Preliminary results indicate that 15-30% weeviling annually on some sites will still yield enough product for the site to show a profit at the end of a rotation. We are continuing to "fine-tune" projection parameters and assumptions.

Pilot Testing of Orthene to Reduce White Pine Weevil Damage on Jack Pine (F. J. Sapio and G. A. Simmons)

Orthene® was tested in three plantations for control of white pine weevil on jack pine. Leaders were hand-sprayed with 0.502 and



0.75 oz. of Orthene/acre with Lindane® at the chemical standard at 0.502/acre. Results were encouraging (weevil damage was reduced) (Figure 3); however, little impact is expected on weevil population levels. Hand spraying, although slow, is cheap and efficient for reducing white pine weevil damage. (Also it limits the amount of insecticide mix applied on a site to an average of one gal/acre.)

Jack Pine IPM Model (R. Drapek and G. Simmons)

A model is being developed to simulate the affects of several insect pests on jack pine growth and yield. Insects to be in the model are jack pine budworm, white pine weevil, and Saratoga spittlebug. Management options in the model include (1) length of rotation, (2) frequency of monitoring, (3) timing of control activities, and (4) types of control activities. Control options will range from pesticide applications to silvicultural techniques. From this model, we will develop a Jack Pine Management game program that will be available on floppy disk and playable on an Apple IIe and the IBM Personal Computer.

Genetic Study of White Pine Weevil (C. A. Chilcote and G. A. Simmons)

The white pine weevil, *Pissodes strobi* Peck, attacks the terminal growth of the host tree, killing the terminal, which results in malformed trunks, and a loss in lumber quality. In recent years, the weevil has become a problem on jack pine as well as white pine. Because of this, we are studying the genetic structure of weevil populations, concentrating on the sympatric populations on both white pine and jack pine. Electrophoresis is being performed on these populations to determine the species status and the possibility that the hosts are attacked by individual biological races. Because recent evidence indicates that biological races may differ in susceptibility to natural enemies, it is imperative to determine the status of different populations. This examination should provide crucial information for future biological control programs for this pest.

The Effect of White Pine Weevil Damage on Jack Pine: 0-10 yrs. (L. J. McKee Jr. and G. A. Simmons)

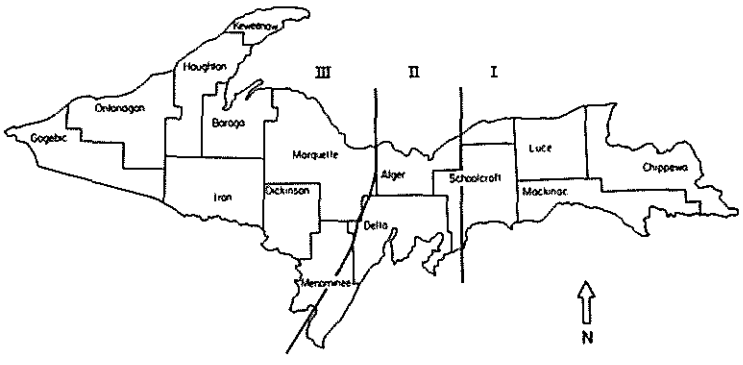
The behavior of the white pine weevil on white pine has been under investigation for some time, yet its behavior on jack pine, a predominant tree species in Michigan, has been seriously under-studied. We are investigating the damage resulting from feeding and oviposition activity and are cataloging their effect on leader diameter, height growth, and ultimate tree form. The relationship of past weeviling to present weeviling will be studied to identify factors that predispose a tree to more than one attack. This study should help risk-rate jack pine plantations and should show what affects the vulnerability and susceptibility of young jack pines to white pine weevil attack.

RESEARCH AT THE U of M

Hazard Rating Spruce-Fir Stands in the U.P. for the Spruce Budworm (A. M. Lynch and J. A. Witter)

A hazard-rating system for the spruce budworm was developed to help forest managers, pest management specialists, and land owners plan strategies to minimize current and future spruce budworm impact in the Upper Peninsula. Almost 200 stands were sampled to develop and validate this system.

Hazard is rated separately for each of three geographic regions (see map this page) reflecting differences in topography, climate, forest structure, management intensity, and timing of the current spruce budworm outbreak. The system cannot be used for wetland sites with organic soils.



To rank hazard for a stand in Region I:

1. determine the basal area per acre in balsam fir (BA.BF) in the stand;
2. determine the percent of stand basal area that is aspen (BA%AP);
3. find the potential for dead fir basal area where these values intersect in Table 8; and
4. compute estimates of potential dead fir basal area (DBA) with the model: DBA = 0.51 + 0.90 BA.BF - 0.26 BA%BP.

Hazard for a stand in Region II is low, with an estimated 4 ± 5 ft^2/ac potential for dead balsam fir basal area.

To rank hazard for a stand in Region III:

1. determine the basal area per acre of balsam fir (BA.BF) in the stand:
   - if this value is 44 ft^2/ac or less, hazard is low, with an estimated 6 ± 7 ft^2/ac potential for dead balsam fir basal area;
   - if this value is greater than 44 ft^2/ac, proceed with 2-5.
2. determine the percent of trees in the stand that are fir (NT%BF);
3. determine the East-West position of the stand locality (range of the U.S. public-land survey Township-Range-Section number);
4. find the potential for dead fir basal area where these values intersect in Table 8; and
5. compute estimates of potential dead fir basal area: DBA = 1.46 + 0.36 BA.BF -0.79 NT%BF + 1.14 Range.

Use the estimates of potential losses to rank stands for vulnerability to the spruce budworm. Prioritize stands for preventive, pre-salvage, and salvage harvest operations, or for remedial treatments based on relative ranks obtained from the absolute estimates of basal area losses. The delineation of low, moderate, and high categories of vulnerability should not be considered fixed. They can be changed by a management specialist or decision-maker to fit various management objectives. The relative hazard rank should be one part in an entire stand management program.

The hazard-rating system is a planning tool for improving decision-making for the spruce budworm. Stand management may provide economic means of minimizing budworm impact, but it will not help control the outbreak.

Table 8. Estimated potential impact to balsam fir basal area (ft^2/ac) in stands on mineral soils in Michigan's Upper Peninsula.

Region I: BA%AP	Pre-outbreak Balsam Fir Basal Area (ft^2/ac) 25	50	75	100	125
0	23	46	68	91	114
20	18	40	63	86	108
40	12	35	58	80	103
60	7	30	53	75	98
80	2	25	47	70	93
95	0	21	43	66	89

Region III: Stands with greater than 44 ft^2/ac of balsam fir basal area.

1. Stand component 50%, by number of stems, balsam fir.

Range[1]	Pre-outbreak Balsam Fir Basal Area (ft^2/ac) 50	75	100	125
28	12	21	30	39
32	16	25	34	43
36	21	30	39	48
40	25	34	43	52
44	30	39	48	57

2. Stand component 70%, by number of stems, balsam fir.

Range[1]	Pre-outbreak Balsam Fir Basal Area (ft^2/ac) 50	75	100	125
28	0	5	14	23
32	1	10	18	27
36	5	14	23	32
40	10	19	28	36
44	14	23	32	41

3. Stand component 90%, balsam fir, by number of stems.

Range[1]	Pre-outbreak Balsam Fir Basal Area (ft^2/ac) 50	75	100	125
28	0	0	0	7
32	0	0	3	12
36	0	0	7	16
40	0	3	12	21
44	0	7	16	25

[1] Range is the stand position of the east-west gradient as noted by the U.S. public-land survey.

Economic Impact of the Spruce Budworm in the Lake States (D. Huff, B. A. Montgomery, G. R. Gregory, and J. A. Witter)

The economic impact of the spruce budworm in the Lake States region has been largely a matter of conjecture. We analyzed the relationship between biological losses and shifts of spruce and fir in supply and demand over the short and long run. Examples of market responses to the budworm are being

analyzed for four forest districts in Michigan's Upper Peninsula. The information should be available by late summer 1984.

Michigan Impact Plot System (J. A. Witter and A. M. Lynch)

The Michigan Impact Plot System (MIPS) was established during 1978-1979 to measure the impact of the spruce budworm in the Ottawa and Hiawatha National Forests. The 136 ground sampling units in the MIPS have been evaluated once each year from 1978 through 1983, and will be sampled in 1984. Impact data by districts and national forests have been analyzed for parameters such as percent fir mortality, total dead volume by host species, dead basal area of host species, and live basal area of host species. Numerous technical reports are available. Contact John Witter if you are interested in these results.

The Spruce Budworm Technology Transfer Program for the Lake States Region (B. A. Montgomery and J. A. Witter, U of M, and R. G. Rogan and G. A. Simmons, MSU)

The Spruce Budworm Technology Transfer Program for the Lake States region was a proto-typical technology transfer project. The program has consisted of three phases: (1) the administration of two needs-assessment surveys of the project target audiences, (2) development and implementation of information/educational packages and activities, and (3) formal and informal evaluation of these products and activities. Important to the effective implementation of the program has been active target audience input into all three phases.

Needs-assessment surveys of forest managers and pest management specialists indicated that the technology transfer team should produce information packages on spruce budworm biology, insecticides, silviculture, remote sensing, and insect impact. Manuals, technical reports, handbooks, leaflets, and videotapes have been developed.

PROJECTS OF THE DNR IN THE U.P. (R. Heyd, DNR)

Herbicide Programs (R. Heyd)

The forest pest management program assists the forest cultivation program by prescribing herbicide use for multiple-use areas (e.g., timber, wildlife, recreation, fisheries, aesthetic). The goal of the program is to enhance the survival and growth of desirable trees and other vegetation by limiting the growth of competing vegetation. Herbicides with low toxicity to people and wildlife are used, and applications are timed to minimize the impact on potential users.

Baraga Forest Area: Dowpon M at 10 lbs./acre was applied in August to suppress a dense grass and sedge cover on a 5-acre site. A boomless spray system was used. Containerized larch seedlings were planted on the site in September.

Escanaba Forest Area: Velpar L at 1 gal./acre in 36 gallons of water was used to suppress scattered aspen and maple regeneration on two sites totalling 57 acres. A boomless spray system was used. Red pine will be planted in 1984.

Ishpeming Forest Area: Two projects were completed in August, 1983. The first was experimental, the second was an operational application. Both projects used 2 qts. Roundup/acre in 36 gallons of water.

In the first project, two site-preparation treatments were replicated three times in 5-acre blocks on a 70-acre jack pine site. One treatment was a broadcast spray using a boomless spray system. The second treatment was 2-ft.-wide sprayed strips on 8 ft. centers. This project was designed to determine the difference in height growth and tree survival between areas where all grass and low shrubs are suppressed vs. areas with 2-ft.-wide strips suppressed vs. untreated areas. Jack pine will be planted in this area in 1984.

The second project was a broadcast application using a boomless spray system to suppress aspen suckers on a 30-acre parcel. Red pine will be planted in 1984.

Gwinn Forest Area: In early June, Velpar L at a rate of one gal./acre in 36 gallons of water was applied with a boomless spray system to 60 acres of scattered aspen and hardwood sprouts. A similar, contiguous 40-acre area was treated with Roundup (2 qts./acre) last fall using a similar spray system and carrier rate. Roundup suppressed woody and herbaceous vegetation this year, although wild buckwheat *(Polygonum sp.)* invaded isolated areas. Velpar L did not suppress vegetation as well as the Roundup. Although aspen and grass suppression was satisfactory, we will wait until next year to see if the black cherry and sugar maple regeneration survived.

Sault Ste. Marie Forest Area: Spot gun applications of Velpar L were used to release 20 acres of planted red pine. Aspen suppression was good; however, we are waiting until 1984 to determine if maple and cherry suppression is satisfactory.

Michigan Youth Corp Program (R. Heyd)

The Forest Pest Management Program had five Michigan Youth Corp (MYC) crews. Each crew had 8 members and a crew leader. Crew leaders were graduates in forestry or biology. Crews were stationed at Baraga, Marquette, Shingleton, and Newberry (2 crews). They were trained to recognize the more common forest pest problems and were instructed in making pest observation reports. Basically, the project included the following tasks:

1. Intensively sample grubs on proposed planting sites and young plantations. Record amounts and types of ground cover for correlation analysis with grub population data. White grubs cause heavy, and often overlooked, losses in our regeneration efforts in many areas.
2. Survey for jack pine budworm. Conduct detection surveys in susceptible jack pine types to find and delimit epicenters where budworm populations are building in preparation for the expected epidemic. If detected, record numbers of pupal cases per branch and degree of defoliation. (Information to be used for possible epicenter suppression project using *B.t.*)
3. Detect gall rust in jack pine stands. Evaluate incidence and size of branch and main stem galls in 30 tree plots. Gall rust is adversely impacting jack pine regeneration efforts in many areas.

We recorded tree survival, tree height, ground cover type, trees/acre, and any observed problems in all plantings.

The data from this project was taken to the Department of Forestry at Michigan Technological University for summary and analysis. The results will be available by Spring, 1984.

Operations Inventory: New Stand Condition Report (R. Heyd)

A form to more thoroughly report stand condition in conjunction with Operations Inventory (O.I.) was distributed for use in early December. Forms are completed if a stand shows problems. Insect and disease conditions are presently monitored in all stands and coded in the O.I. system. This form provides additional computer storage for important stand condition information that can be assessed and manipulated in conjunction with the O.I. system.

Completed forms are sent to the regional forest pest specialist. Field reviews and evaluations are then conducted. Summaries of stand conditions by compartment with recommendations are sent to the forest area well in advance of a compartment review. In time, stand condition reports will provide a measure of product quality for marketing, use, and management studies. They will record the magnitude and distribution of given problems, thus enhancing our ability to evaluate impact and define management and research needs.

Balsam Fir Sawfly *(Neodiprion abietis)* (R. Heyd)

Balsam fir along M-35 in Delta County, south of Escanaba, were noticeably defoliated by the balsam fir sawfly. New growth was little affected, but older needles were turning brown.

Sawfly pupae were collected for Dr. Harold Coppel, University of Wisconsin, who is working on sawfly taxonomy using

electrophoresis. Additionally, Dr. John Cunningham at the Forest Pest Management Institute in Sault Ste. Marie, Ontario, is interested in collecting sawfly egg masses from this area this winter. Dr. Cunningham is working with a nuclear polyhedrosis virus for the balsam fir sawfly.

VEGETATIVE COMPATIBILITY GROUPS, WATER POTENTIAL, & *Cytospora kunzei*

(T. J. Proffer and J. H. Hart, MSU)

Cytospora kunzei isolates were collected from 46 resinous branch cankers on 32 spruce (*Picea* spp.) in six locations. Vegetative compatibility (vc) pairings of 108 isolates on potato dextrose agar indicated that there are at least 24 vc-groups of *C. kunzei* in Michigan. Isolates from a single canker were always contained within the same vc-group. Separate cankers on a single tree sometimes contained different vc-groups.

The effect of water potential in the *in vitro* growth of *C. kunzei* was examined by varying the water potential of the medium by adding various solutes: KCl, NaCl, sucrose, mannitol, and polyethylene glycol. Fungal growth was measured as increases in colony diameter or weight. At 26°C, the maximum growth of *C. kunzei* occurred at water potential ranges of -2.6 bars for NaCl to -15 bars for sucrose. The growth response to water potential differed with which osmoticum was used.

BIGTOOTH ASPEN AND SEWAGE SLUDGE

(J. H. Hart, MSU)

During the summers of 1982-1983, bigtooth aspen were dying in some plots near Atlanta, Michigan. The research reported here is part of a long-term study to determine the effect of sewage sludge on various forest ecotypes.

Field observation and laboratory cultures determined the following.

1. *Cytospora chrysoperma* is a primary pathogen in the stand and is the direct cause of most big tooth aspen mortality, especially of big tooth aspen broken over by elk.
2. *Armillaria mellea* occurring in the stand is a primary and secondary pathogen. It appears to be a more important pathogen on unbroken aspen than on those broken by elk. Its distribution is erratic.
3. *Fomes applanatus* and *Agrilus liragus* are present. Their role as agents of mortality is unknown, but appears to be insignificant.
4. Lesions noted in 1982 are sunscald lesions.
5. Sludge treatment does not cause mortality, although it may have an indirect effect. The sludge treatment probably increased the susceptibility of the big tooth aspen to the pathogens; increased elk damage thereby predisposing the aspen to disease, and delayed fall dormancy, resulting in increased winter injury which predisposed the trees to disease. Trail construction may have increased the incidence of sunscald, which increased disease incidence.

RESEARCH & PROGRAMS AT THE MTU

(J. N. Bruhn, MTU)

Logging Damage Inventory (J. N. Bruhn)

Logging damage was inventoried in conjunction with a Forest Service mechanized strip-selection thinning study in northern hardwoods. The experimental thinning was conducted by the Houghton, Michigan, Forestry Sciences Laboratory, North Central Forest Experiment Station, on Wisconsin DNR lands near Spooner, Wisconsin. Descriptive data were collected for 639 wounds on residual stems. Data will be used to compare the impact of different thinning operations on residual stands, to develop guidelines for reducing damage, and to evaluate wound-healing and associated defects by tree species. The Spooner study has added valuable data primarily on northern red oak to that collected primarily for sugar maple in the 1981 Watersmeet, Michigan, block-thinning.

Shingleton Reforestation Trials (J. N. Bruhn and R. Heyd)

The Shingleton Reforestation trials is a continuing cooperative project between the Forest Management Division of the DNR, MTU, and the Michigan Cooperative Tree Improvement Program. The purpose is to determine the feasibility of reforesting areas within the Kingston Plains, Fox River Plains, Sucker River Plains, and Danaher Plains (approximately 50,000 acres) in the Shingleton Forest area of Michigan's Upper Peninsula.

The primary goal of this project is to develop techniques for the successful establishment and rapid initial growth of tree species suited to these sites.

This year's planting trials focused on white grub control, lichen control, and species trials. Two doses of a biological control agent, *Bacillus popillia*, and two doses of a liquid formulation of the insecticide Oftanol (isophenphos) were applied around seedling root systems to control white grubs.

Raking and no-raking treatments for lichen control were included within each grub control treatment. Copper sulfate ($CuSo_4$) could not be used to suppress lichen due to application problems and an apparent lack of lichen response to preliminary copper sulfate treatments. Grub control x lichen control were replicated within separate plantings of red pine, jack pine and *(Pinus nigia* x *P. densiflora)*. The root systems of the bare-root stock were coated with Liqua-Gel to keep root systems moist when exposed to air.

A site was prepared in September adjacent to this year's planting trials for a lichen control x mycorrhizae x seed source trial using containerized red and jack pine. A control burn will be used for lichen control. Mycorrhizae *(Suillus sp.)* isolated from an area similar to the planting site, is being grown. Innoculated and not-innoculated containerized seedlings will be replicated within the lichen planting areas testing Upper Peninsula vs. Northern Lower Peninsula seed sources for red and jack pine. This planting trial is scheduled for the Fall, 1984. We also plan to begin trials testing the survival and growth of native and introduced hardwood species suited to these sites.

Results to Date: This year's and last year's Shingleton Reforestation Trials were devastated by this summer's severe drought (less than 1 1/2" rainfall from June through mid-August). The Byram-Keetch fire drought index exceeded 400 from mid-July through mid-August. We will determine which treatments had the best survival and which mycorrhizal associations survived the drought. We will view this year's severe conditions as a periodic limiting factor in our analysis of reforestation efforts.

1982 Plantings: Three pine plantations established in 1982 on the Danaher and Fox River Plains of Schoolcraft County were surveyed 100% at the close of the 1983 field season. These plantations were established to evaluate the effectiveness of pre-plant Roundup (glyphosate) and furrowing, as well as three species of endemic nursery mycorrhizae, on regeneration survival.

Survival, approximately 90% in each plantation in 1982, dropped drastically in 1983 due to white grubs, drought, and their interaction. Red and jack pine survival on the Danaher Plains declined to 21.3 and 7.7%, respectively, while red pine survival on the Fox River Plains dropped to 32.6%.

An application of 5% granular Amaze (isophenphos) at planting did not control grubs. The liquid formulation, or autumn application of the granular formulation, at pre-plant might be more effective.

The pattern of mortality among treatments suggests that Roundup, in the presence of drought and white grubs, increases seedling mortality by focusing grub feeding onto the regeneration. Furrowing appeared to alleviate the grub problem slightly where Roundup was applied, but may have increased the drought susceptibility of regeneration. Approximately 10% of the surviving red pine seedlings were infested with red pine needle midge at the close of 1983. Midge activity was not related to site preparation techniques. These plantations will be evaluated again at the close of 1984.

1983 Plantings: Grub populations were down this year. This along with drought-induced seedling mortality has masked results of our grub control experiments with *Bacillus*

popillia and isophenphos. We will retest these materials as grub populations build again.

Oak Wilt Control in Menominee County (J. N. Bruhn, MTU; R. L. Heyd, DNR; E. Abel, MDA; R. Breyer, MSU Coop. Exten. Serv.)

Approximately 3,000 red oaks have been killed in the last 10 years in Lake Township, Menominee County, between the Shakey Lakes County Park and the Menominee River (about 30 infection centers). In 1983, data were collected from 16 centers characterize disease spread via computer mapping. Seventeen centers were treated, experimentally, with the downward-mobile herbicide Tordon RTU to prevent spread via root grafts. The effectiveness of Tordon will be evaluated early in 1984. Plans for the 1984 field season include aerial surveillance; marking trees, which could produce spring inoculum, for removal; and confining the remaining centers by herbicide and/or vibratory plow.

Armillaria Genetics and Root Disease Epidemiology (J. N. Bruhn, MTU)

Certain species of *Armillaria* cause serious mortality in conifer plantations following hardwood liquidation. We are working to determine the identity and ecology of *Armillaria* species in the U.P. This information will form the basis of a predictive system for evaluating the root disease threat posed by conversion of specific hardwood stands to conifer plantations.

Single-basidiospore isolates have been obtained from over 20 *Armillaria* spp. collections in the western U.P. and Wisconsin. A reference collection of freeze-dried fruiting bodies has been initiated for morphological and anatomical characterization. Single-spore isolates are being used to develop techniques for genetic analysis of the collections.

Armillaria root disease mortality continues to be documented on one Baraga County site converted from northern hardwoods to red pine in 1981. Mortality attributable to *Armillaria* has been light to date.

Pine Mycorrhizae Research (J. N. Bruhn, MTU)

Shingleton Reforestation Trials: This year's drought caused heavy mortality in the originally established nursery mycorrhizae plots. However, three jack pine seedlings of the 1450 planted exceeded 50 cm in total height and nine others exceeded 40 cm. Superior growth may be related to seedling genotype. Considering the obligately mycorrhizal nature of jack pine, the mycorrhizal fungi associated with these 12 specimens must be well-adapted to droughty sites. Plans for 1984 include attempts to isolate mycorrhizal fungi from a number of these seedlings. Isolates would be included in tests of the feasibility of producing inoculated seedlings well-adapted to survive on droughty sites.

Dickinson and Marquette Counties: Shifts in red pine mycorrhizae populations following planting on Acer-Quercus-Vaccinium habitat types will be monitored at three locations in Dickinson and Marquette counties beginning with spring planting in 1984. The A-Q-V habitat is one of the hardwood habitat types most frequently targeted for conversion to conifer plantations. Preliminary surveys of mycorrhizal fungi fruiting in the Toumey Nursery and at two of the planting sites were conducted in 1983. Reference collections of pure cultures from identified fruiting bodies and of freeze-dried fruiting bodies have been initiated. This study eventually should help in identifying those mycorrhizal fungi best able to aid red pine establishment on A-Q-V habitat sites.

PUBLICATIONS OF

THE MICHIGAN COOPERATIVE FOREST PEST MANAGEMENT PROGRAM IN 1983

1. B. A. Montgomery, J. A. Witter, and G. A. Simmons. Identifying the spruce budworm and its damage. Leaflet 83-7.

2. B. A. Montgomery, J. A. Witter, G. A. Simmons, and A. M. Lynch. The effects of spruce budworm outbreaks on trees and stands. Leaflet 83-8.

3. B. A. Montgomery, J. A. Witter, G. A. Simmons, and A. M. Lynch. Identifying stands with the greatest potential for tree mortality. Leaflet 83-9.

4. B. A. Montgomery, G. A. Simmons, and J. A. Witter. Monitoring spruce budworm populations and damage at the stand level. Leaflet 83-10.

5. G. L. Baskerville and B. A. Montgomery. Forest management. Leaflet 83-11.

6. B. A. Montgomery, C. L. Hatch, G. A. Simmons, and J. B. Dimond. Insecticides. Leaflet 83-12.

7. B. A. Montgomery, J. L. Flexner, J. A. Witter, and G. A. Simmons. Silviculture. Leaflet 83-13.

8. R. G. Rogan and G. A. Simmons. The feasibility of audio-cassette tapes in technology transfer: the spruce budworm technology transfer program. Tech. Rpt. 83-1. 13 pp.